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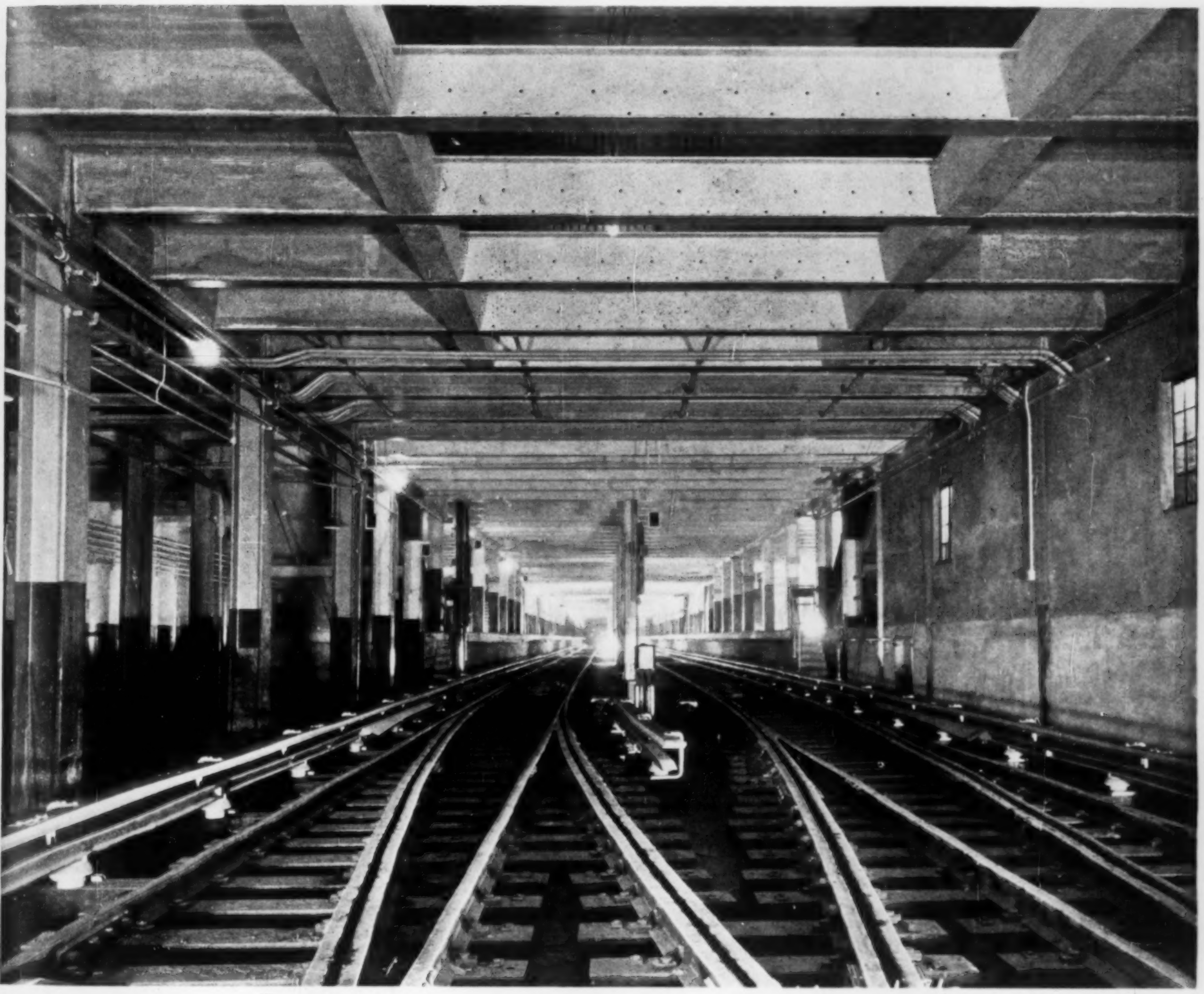
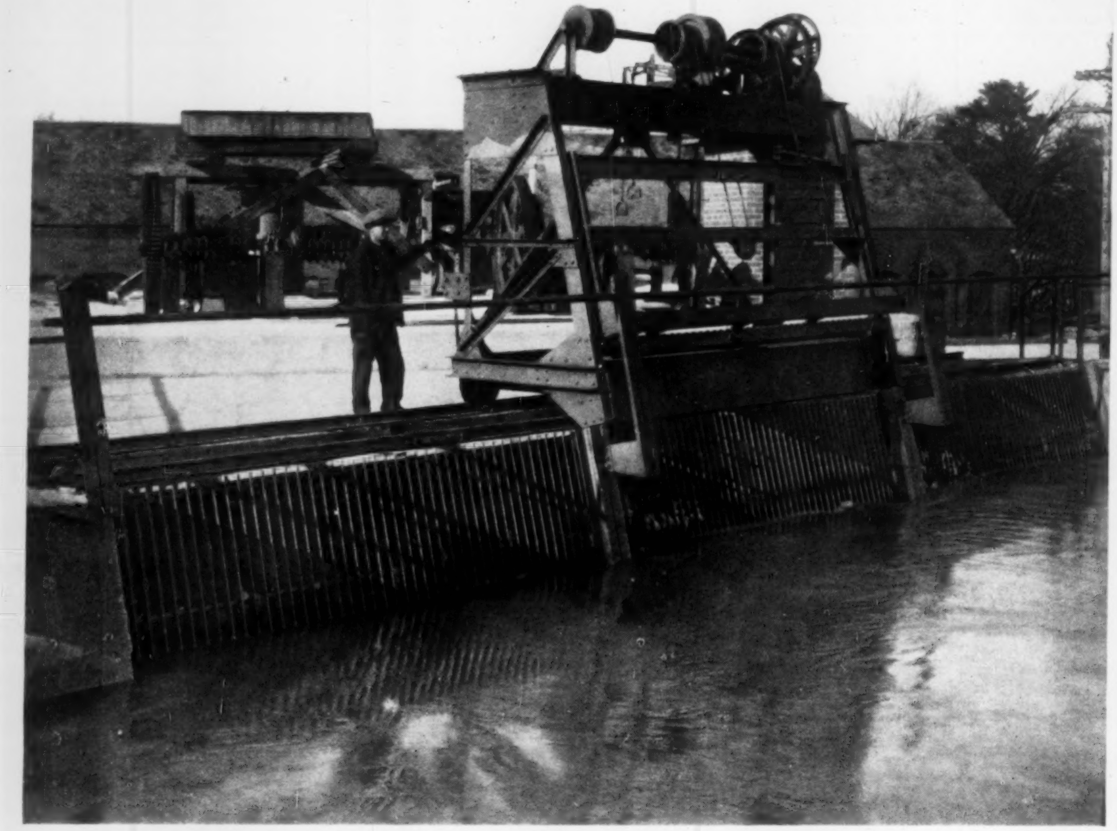


Subway Construction at Walnut–Locust Station, Philadelphia

Volume 3 *Number 12*

DECEMBER 1933



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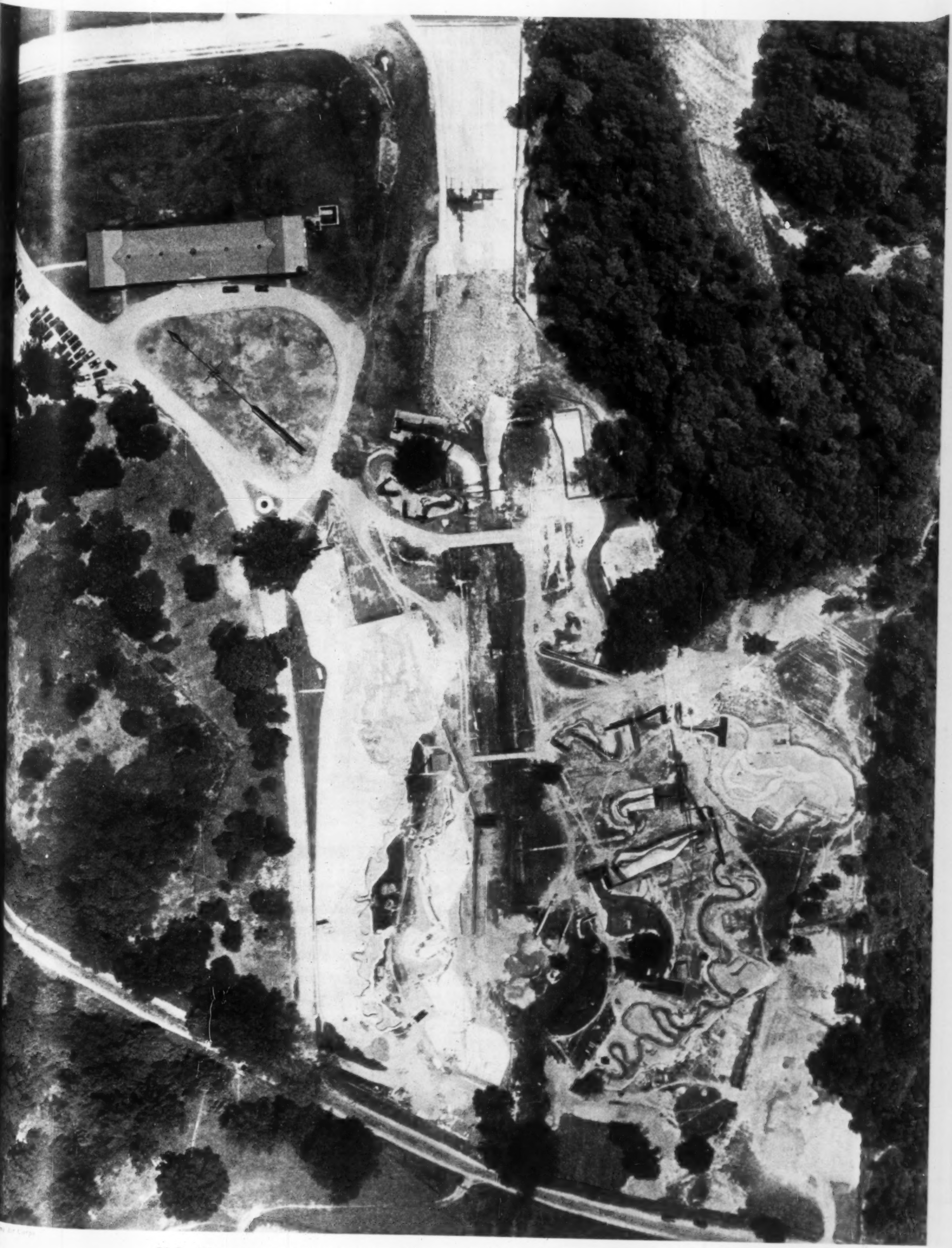
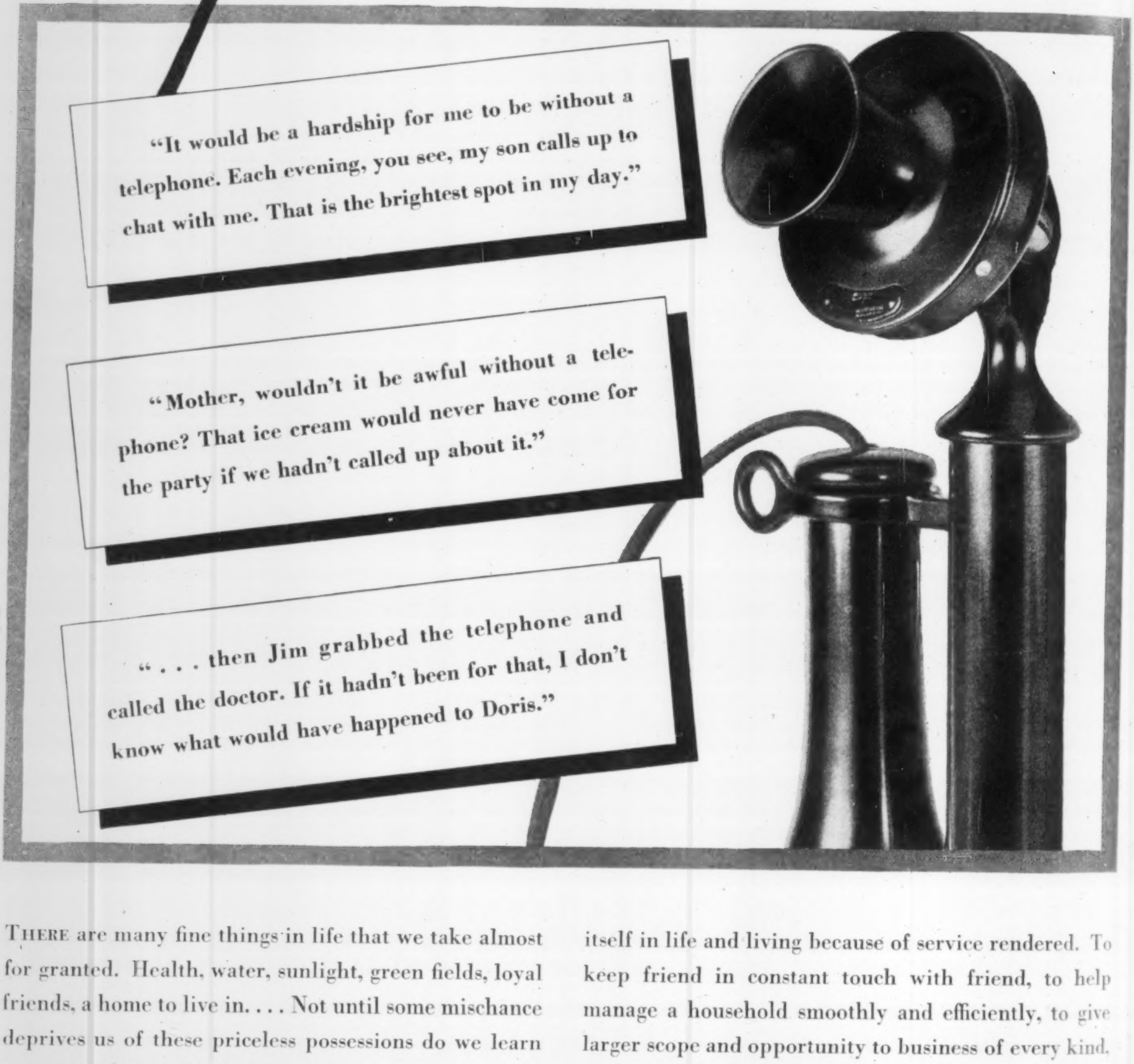


Air Corps

U.S. WATERWAYS EXPERIMENT STATION AT VICKSBURG, MISS., FROM THE AIR (*See page 724*)

A *Friend* in the house



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Among Our Writers

T. B. Larkin, after graduation from West Point, attended the Engineer School, Washington Barracks. A year with the Mexican Expeditionary Force was followed by two years with the A.E.F. Then, in succession, he was an instructor at the Fort Humphreys Engineer School; Assistant Military Attache, Tokyo, Japan; Assistant to the District Engineer, Pittsburgh, Pa.; in the office of the Chief of Engineers, Washington, D. C.; and District Engineer at Vicksburg, Miss.

Henry M. Waite spent the first 17 years of his professional career on railroad construction and operation. He was then consecutively Chief Engineer of the Department of Public Service of Cincinnati and City Manager of Dayton. In the A.E.F., Colonel Waite was Chief Engineer of the Department of Transportation. On his return to New York he was engaged on construction work and in private practice until 1927, when he returned to Cincinnati to build the Union Terminal there.

Oren Reed, a 1922 graduate of Purdue University, in that year was sent to Norway as a Fellow of the American-Scandinavian Foundation to study hydroelectric developments. From 1923 to 1929 he was Assistant Designing Engineer with the San Joaquin Light and Power Corporation. A second fellowship to study the design of electrical machinery in Sweden was awarded to him in 1929. He has previously contributed to CIVIL ENGINEERING.

William J. Krefeld is a graduate of Columbia University, and has been a member of the faculty of the Columbia Engineering School since 1917. In addition to giving instruction in the Department of Civil Engineering, he is Engineer of Tests in the Testing Laboratory, in which capacity he has conducted numerous investigations involving structural materials.

Herbert S. Swan is the author of many articles and reports on zoning and city planning and has acted as consultant in these fields to numerous cities. He has previously contributed to the pages of CIVIL ENGINEERING.

Shirley Baker graduated in 1895 with the pioneer class of Stanford University. For 12 years he served as engineer and manager of the Redwood Manufacturers Company on the installation of wooden pipe lines throughout the United States, and later was construction engineer of the Panama Pacific Exposition. Among his more recent works is the Stanford Stadium, which he designed and built. Major Baker spent 17 months overseas with the A.E.F.

U. B. Gilroy has had 13 years of professional experience, including hydraulic investigations in the Hawaiian Islands and the State of California; work as field engineer on construction layout, surveys, and appraisals in the oil industry; and experience as field engineer on the testing of gold-bearing gravels and studies of design of debris storage dams for the Hydraulic Mining Commission of California.

Arthur V. Sheridan obtained his education at the College of the City of New York and Columbia University. He holds a certificate as Ingenieur from the École Nationale des Ponts et Chaussés, France. His engineering experience, except for service in the A.E.F. during the War, has been in New York on municipal improvements. He is a former president of the New York State Society of Professional Engineers and now is the editor of that society's publication.

Sheldon A. Keast became connected with the American Bridge Company in 1912 and subsequently became designer in the Department of City Transit of the City of Philadelphia. During the War he was Chief Draftsman of the Yard and Plant Division of the New York Shipbuilding Corporation. After experience as engineer for various engineers, architects, and contractors, he accepted his present position in 1924.

W. N. Brown began his topographic work as a topographer for the U.S. Geological Survey. In 1911 he executed the topographic survey of Cincinnati and in 1915 opened a consulting office under his own name. He had charge of the topographic survey of Naval Oil Reserve No. 1, and executed the topographic survey of Louisville, Ky. Recently he executed surveys of the Upper Mississippi River and of parts of the White and Wabash rivers.

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December 1933

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Number 12

Machines Aid in Combatting Floods

Excavation Difficulties Encountered and Equipment Used Along the Mississippi River

By T. B. Larkin
Member American Society of Civil Engineers
Major, Corps of Engineers, U.S. Army; District Engineer, Ft. Peck District, Glasgow, Mont.

Dirt-moving on a grand scale comprises a large part of the work of the Mississippi River Commission in its flood-control program following, and based on, the act of May 15, 1928. Already well over 300,000,000 out of a total of 650,000,000 cu yd of levee excavation has been completed. To handle this immense volume of earth, as well as to carry out the necessary dredging operations, has involved improvement in methods and machines. Major Larkin's intimate contact with this work, as District Engineer for the Vicksburg District, qualifies him to speak with authority on these problems of excavation and equipment. This paper supplements his previous article, which appeared in the October issue, covering general phases of the Mississippi River Flood-Control Project.

Following the disastrous floods which ravaged the Mississippi Valley in 1927, public consciousness was aroused to the point of action in order to assure positively against the recurrence of such a catastrophe. Accordingly, plans were prepared by the U. S. Engineer Corps, and appropriate legislation in line with them was adopted by Congress. The Flood-Control Act of May 5, 1928, envisaged a ten-year program of comprehensive works to guard the entire alluvial valley.

Largely it is a dirt-moving job. In all, 1,900 miles of levees, comprising almost 650,000,000 cu yd of excavation, is involved. Enough of this program has already been accomplished to indicate the difficulties of the work and the measures necessary to its success. Progress on levee construction both present and prospective, is indicated in Table I.

Under the ten-year program, levees are constructed to one of three cross sections, depending on the material available, whether Class A, buckshot (clay); Class B, loam; or Class C, sand. Dimensions and requirements are illustrated in Fig. 1. The seepage line designated for each of the type sections is that gradient which water in a saturated fill will approach in the given type of material when the level of the river is within one foot of the net grade. The following yardages for a levee 26 ft high, for each of the three types of material, will give an idea of the differences in size:

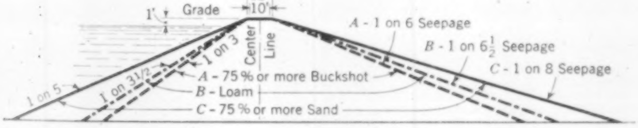


Fig. 1. New-Type Levees Along the Mississippi River

A-section, 11,315 cu yd per 100-ft station
B-section, 12,519 cu yd per 100-ft station
C-section, 16,226 cu yd per 100-ft station

The various restrictions for borrow pits are based on the general nature of the materials encountered on the several reaches as regards their susceptibility to seepage and scour, and the current to be expected. On the lower Mississippi the soils, in general, are more resistant to erosion, and the current is slower, while in the upper reaches of the alluvial valley the river has steeper slopes and greater velocities, and the materials are more susceptible to erosion and seepage. Therefore, in the southern reaches borrow pits can be excavated to greater depths with the same safety as shallower pits in the northern districts, as shown in Fig. 2. In all districts, the borrow-pit specifications can be modified to take care of conditions at a particular locality.

Methods and equipment for levee construction have developed to meet the demand for this kind of work. The first levees required small yardages and were constructed by hand with shovels and wheelbarrows. Next

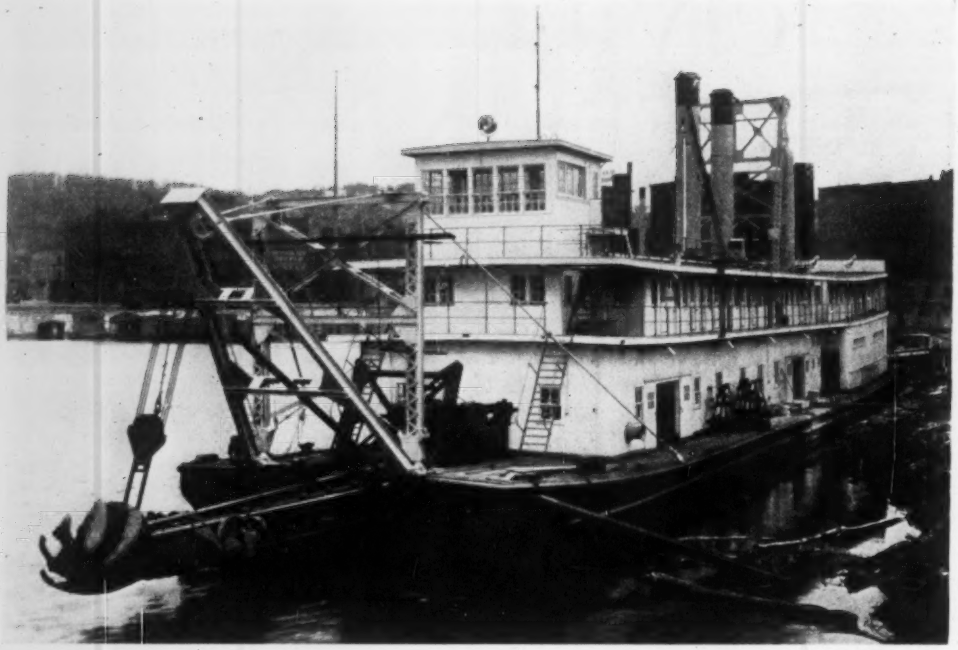
Table I. Progress Made on the Ten-Year Levee-Building Program in the Lower Mississippi Valley

Volumes in Cubic Yards

Year	Memphis District	Vicksburg District	New Orleans District	Total
1928	5,046,000	226,000	4,570,000	9,842,000
1929	10,240,000	8,092,000	9,923,000	28,255,000
1930	13,372,000	28,477,000	27,680,000	69,529,000
1931	22,710,000	35,662,000	33,188,000	91,560,000
1932	27,666,000	37,374,000	39,371,000	104,411,000
To March 1, 1933	4,000,000	1,264,000	3,789,000	9,053,000
Total placed	83,034,000	111,095,000	118,521,000	312,650,000
Under contract to be placed	27,687,000	20,846,000	44,559,000	93,092,000
Proposed to be advertised in 1933–1934	28,000,000	7,279,000	22,000,000	57,279,000
Yardage remaining after 1933–1934	33,000,000	48,300,000*	98,000,000	179,300,000
Grand total under project	171,721,000	187,520,000	283,080,000	642,321,000

Miles placed or under contract	1,100
Total miles in project	1,900†

* Includes 44,000,000 cu yd originally estimated for Boeuf Floodway.
† Includes 242 miles in the Boeuf, and 189 miles in the Atchafalaya Basin.



A Mississippi River Suction Dredge with Cutterhead

came the animal-drawn scrapers, wheelers, and wagons. This type of equipment was extensively used almost up to the beginning of the present flood-control program, although tower machines and drag-lines were then coming into general use. The magnitude and emergency nature of this present program demanded equipment capable of speedily handling large quantities of material. Competition among contractors and manufacturers has done much to perfect such equipment. Animal-drawn units were soon replaced by tractor-drawn wagons. Tower machines, drag-lines, railroad equipment, motor trucks, and other types of machinery have been developed to a high state of efficiency in levee construction since the beginning of the ten-year program in 1928.

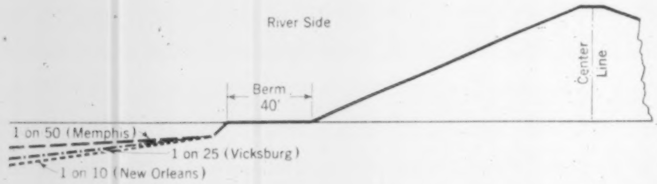


Fig. 2. Cross Sections of River-Side Borrow Pits for Levee Construction

MANY TYPES OF EQUIPMENT USED

Animal-drawn equipment has ceased to occupy the position of major importance it held a few years ago and has now become rare. Dump wagons can still be used advantageously under certain conditions, such as the construction of small levees or the repair of large ones where the quantity of material or the conditions of borrow prohibit the use of mechanical equipment. Animal-drawn scrapers or Fresno scrapers are useful in raising or repairing levees during high water.

Motor trucks have not been used as extensively as other types. Their advantage lies in their great speed and adaptability to an excessively long haul. Their disadvantages are apparent in wet weather.

Recently tractor-drawn equipment has developed very rapidly. Several makes of tractors and dump wagons have been brought to a high state of efficiency in levee construction. The horsepower of such tractors varies from 50 to 80. Diesel-operated tractors are also coming into use. The dump wagons vary in capacity from 5 to 12 cu yd and have either a hand or an automatic dump. For long hauls and for the construction of levees in low and damp locations, the tractor-drawn wagon has a decided advantage over other types. The average unit consists of five tractors and five wagons.

For loading, elevating graders and small drag-lines are used principally. The best balanced and most efficient outfit of this kind is that containing enough carrying units to require uninterrupted operation of both loading and hauling equipment. The capacity of one carrying unit varies from 75,000 to 125,000 cu yd per month.

LARGE MACHINERY FOR HEAVY WORK

Drag-line equipment includes long-boom machines on railroad tracks, on "walkers," and on caterpillars—all with buckets from 4 to 10 cu yd in capacity and boom lengths of from 90 to 175 ft. The efficiency of such equipment has been greatly increased by the development of lighter and larger buckets and of longer booms, made possible by the substitution of aluminum alloy for steel. This equipment can be used most advantageously and economically where the borrow pit is close to the levee, as at sites below the Red River, where the pits have a slope of 1 on 10. However, with auxiliary equipment to cast more distant material within reach, this type can be used where the borrow pit is

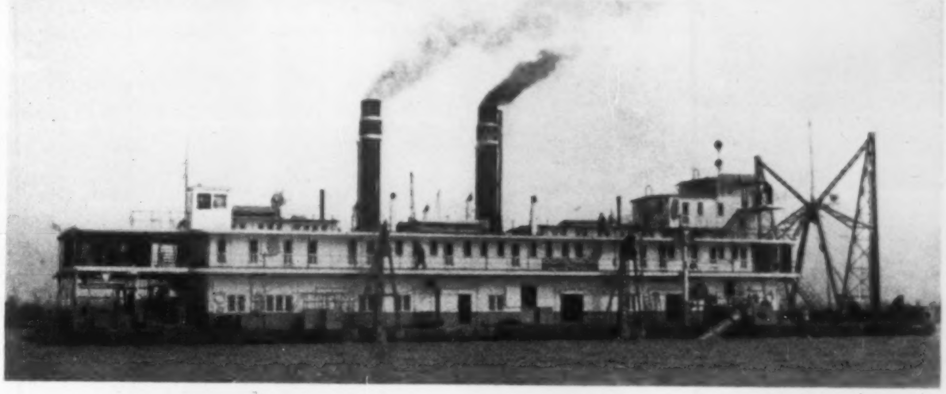
Tractor-Drawn Caterpillar Wagon in Use on Palmetto-Courtableau Levee, Mississippi River

Such Equipment Is Well Adapted to Long Hauls and Damp Localities ome distance from the levee. The output of a drag-ne with a long boom and a large bucket is from 130,000 to 160,000 cu yd per month.

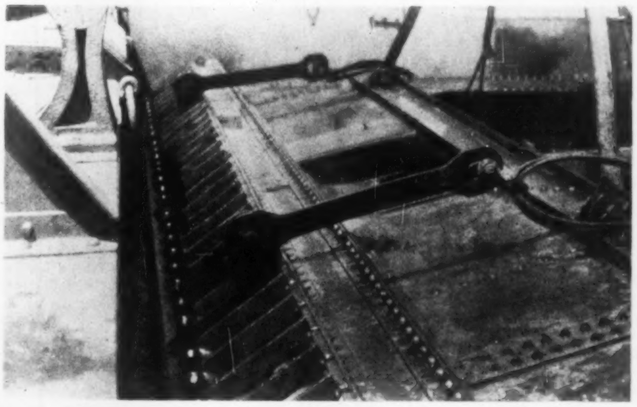
Tower machines driven with both steam and electric power have proved to be very efficient and speedy. For large levees and clear digging, tower equipment is hard to excel. The ideal combination is to have tower machines for the main work and a tractor-and-wagon outfit for constructing "tie-ins," for long hauls, for side borrow pits, and for fills across sloughs and swamps. Often two large tower machines are worked in tandem, one placing material in the back slope and the other following and completing the levee. Such machines vary in height from 90 to 130 ft and in bucket capacity from 7 to 12 cu yd. Their maximum span is well over a thousand feet. Their output has been greatly increased by the development of light buckets of large capacity and has reached 280,000 or 300,000 cu yd per month.

Hydraulic dredges are used advantageously for filling deep blue holes caused by levee crevasses, filling old borrow pits, making fills across lakes, and placing sandy material at locations where dry borrow-pit material is not available. At first it was thought that a large part of the levees might be built by hydraulic dredge, especially as there was a considerable amount of this equipment available and its cost of operation was relatively low. However, it was soon learned that though it is suitable for building sand levees and making fills, it is not adapted to the building of buckshot or clay levees, for apparent reasons.

Practically the entire section of the hydraulically-built levee is placed wet, except relatively small retaining dikes on the sides. Wet buckshot, which dries very slowly, cannot support a load of one ton per square foot. A 28-ft levee has a base load in excess of $1^1/_2$ tons per sq ft. This results in slides despite the presence of retaining walls. Also, by the action of the cutterhead, the pump, and the water flowing through the pipe line, the different constituents of the buckshot are segregated. Unless special precautions are taken, large pockets of segregated silt result and prevent the formation of a satisfactory levee. Mainly because of the increased efficiency and lower unit costs of other types of equipment, the use of hydraulic dredges for levee construction, except in special cases, has been abandoned.



DREDGE "OCKERSON" CONVERTED FOR SIDE-DRAG DREDGING
Drag Pipe Has a Diameter of 30 In. and a Length of 97 Ft from Trunnion to Drag Head



CLOSE-UP OF THE "DUST-PAN" OF A DREDGE
Such Dredges, with a Suction End 32 Ft Wide, Move Material at Low Unit Cost

The dredges used varied in horsepower from 300 to 3,300; in diameter of discharge pipe, from 10 to 27 in.; and in length of such pipe, from 1,000 to over 20,000 ft.

Railroads of narrow gage have been found of use in levee construction. For levees requiring the transportation of material for long distances they have proved economical and efficient. For ordinary use, however, the railroad cannot compete with other types of equipment. A railroad outfit is capable of hauling as many as ten 12-cu yd cars at one time. By a system of switches, more than one train can be used on the same track. Since the cars are equipped with automatic dumps, they can be quickly unloaded.

Miscellaneous equipment in addition to that mentioned has been used to small advantage. Conveyor outfits are being tried at the present time, and it is understood that so far they have met with a certain amount of success.

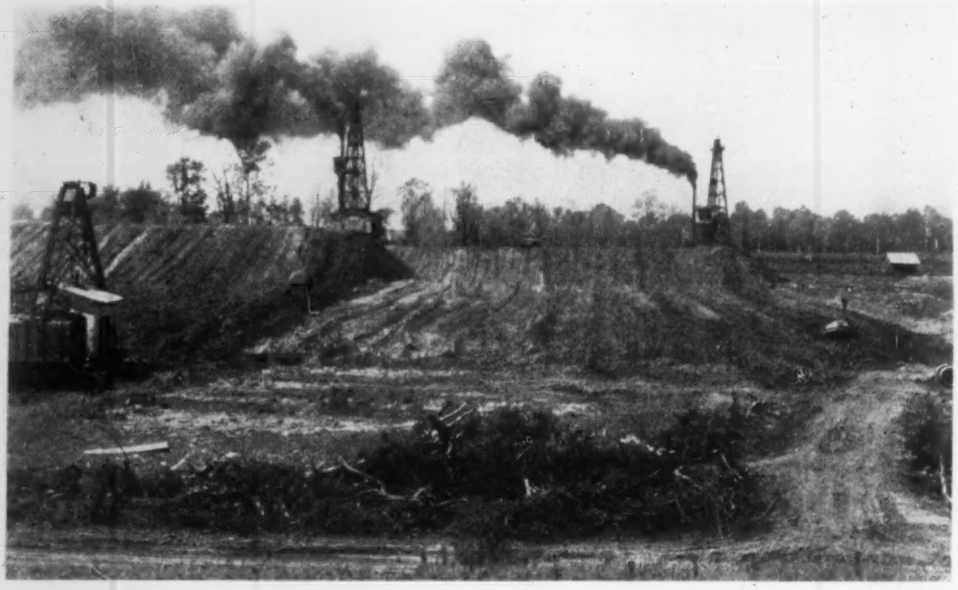
Average lengths of haul for a standard B-section levee 25 ft high, under the various specifications for borrow pits (Fig. 2), are as follows:

SLOPE	DISTRICT	AVERAGE LENGTH OF HAUL
1 on 50 slope	Memphis	453 ft
1 on 25 slope	Vicksburg	372 ft
1 on 10 slope	New Orleans	285 ft

It is evident that borrow-pit specifications have a direct bearing on the types of equipment predominating in each district. In the Memphis District, where the slopes are generally 1 on 50, the long haul gives the contractor employing tower machines an advantage in bidding. In the Vicksburg District, the slope of 1 on 25 favors the use of towers and tractor-drawn equipment. In the New Orleans District, below the Red River, where the pits have a slope of 1 on 10, boom machines have a decided advantage.

Since the time of the earliest settlers, the Mississippi River has been one of the main arteries of commerce for the territory through which it passes. The first navigation was by canoe; then followed in succession the flat boat, the keel boat, the primitive steamboat, the river packet, and finally, the highly developed river boat with great tows of barges loaded with products of all kinds. The adopted flood-control project provides for a channel 9 ft deep and 300 ft wide, to be secured by dredging and by the construction of reveted contraction works.

The problem of navigation differs widely in each of the three districts. In the Memphis District the channel wanders considerably, slopes are relatively steep, and the river banks are rather easily eroded. In the Vicksburg District the channel is more stable, the slopes are less steep, and the banks less friable than in the Memphis District. In the New Orleans District the slope is relatively slight, and the river banks, especially below Baton Rouge, erode comparatively little. For these reasons the Memphis District has by far the greatest navigation problem; whereas the Vicksburg and New Orleans districts encounter relatively few difficulties in maintaining the projected channel.



TWO TOWER EXCAVATORS IN TANDEM BUILDING A LARGE LEVEE
Between Mascot and Indian Bend, La., in August 1932

In the Memphis District the navigation features of the project are carried out by contraction works, revetment, and dredging. Prior to 1928 there were no contraction works below Cairo. To date, 170,000 lin ft of such works have been built in the Memphis District.

Two types of dredges are used in this section, the cutterhead and the dust-pan. The cutterhead dredge is used principally in clay and gravel beds. The dust-pan dredge, which is the more common, is employed primarily for dredging the crossings, which become evident at low stages. On the dust-pan dredge the suction end is 32 ft wide, so that it covers a much greater width than the cutterhead. The dust-pan dredge has been found to have high efficiency with low unit cost.

LONG-BOOM DRAG-LINE EXCAVATOR CONSTRUCTING A LEVEE IN LOUISIANA

BOATS THEMSELVES UTILIZED TO SCOUR OUT SOME CROSSINGS IN VICKSBURG DISTRICT

In maintaining the navigable depth in the Vicksburg District, reliance is placed principally on the proper marking of the crossings. Buoys are used to indicate the exact location of the best channel over shoals. At some shoal crossings navigation itself has been utilized to maintain a channel by means of a double line of buoys fairly close together. As the screw-propeller boats pass through this narrow lane, the action of their propellers scours out a channel.

During the low-water season navigation has always been hazardous at night and until recent years has been confined largely to daylight. With the increased amount of river traffic, however, uninterrupted navigation has become necessary. In order to reduce night hazards, electrically-lighted buoys are being developed.

Shortly after work on this project was started, contoured and colored maps of the alluvial valley, to scales of 1:250,000 and 1:500,000, were prepared from data available in the three districts. Since then, surveys have been completed for a more accurate detailed map of the alluvial valley to a scale of 1:62,500. All the quadrangle sheets, to this scale and contoured, have now been submitted to the Engineer Reproduction Plant for publication in colors. A revised map to a scale of 1:250,000, also in colors, is being prepared in eight sheets, four of which have already been submitted to the Engineer Reproduction Plant for publication.

Under the Flood-Control Act the Federal Government has no obligation to construct or maintain levees on tributaries outside the backwater limits of the Mississippi River. The approved plan does provide, however, that the Federal Government may repair flood damage to control works on any of its tributaries. The Government has no control over the location, design, construction, or coordination of these works beyond the backwater limits. Local interests and the states themselves are responsible for these features.

This ten-year flood control project is in charge of Edward M. Markham, M. Am. Soc. C.E., Major-General, Chief of Engineers; Harley B. Ferguson, Brigadier-General, Corps of Engineers, President of the Mississippi River Commission; and the following District Engineers: Memphis District, B. B. Somervell, M. Am. Soc. C.E., Major, Corps of Engineers; Vicksburg District, T. B. Larkin, M. Am. Soc. C.E., Major, Corps of Engineers; and New Orleans District, J. N. Hodges, Lieutenant-Colonel, Corps of Engineers.

Organization and Problems of the PWA

Aims and Accomplishments of the Federal Emergency Administration of Public Works Outlined

By HENRY M. WAITE
MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
DEPUTY ADMINISTRATOR OF PUBLIC WORKS, WASHINGTON, D.C.

THAT the labor of organizing the Public Works Administration and of developing administrative policies for the allotment of three and one-third billion dollars is little short of herculean, is generally admitted. This organization was developed so rapidly that many interested engineers do not know the part that is played in it by the Planning Board, the Labor Board, the Board of Review, the State Advisory Boards, the State Engineers (PWA), and the Regional Advisers. In this article, Colonel Waite touches briefly on the function of each part of his organization and continues with information concerning such matters as grants, interest rates, and minimum wage scales. Now that $2,700,000,000 has already been allotted, he is confident that public works projects for the remainder of the fund available will be selected by the end of the year.

SOME of the problems encountered in allocating the Public Works fund of $3,300,000,000 may be of interest to engineers. This is a stupendous sum of money to be spent in a short time within the requirements of the National Industrial Recovery Act drafted by President Roosevelt and Congress, and yet progress is being made that should be evident.

As a matter of explanation, this act is divided into two parts. Title I is known as the NRA and was designed for the purpose of encouraging national recovery by coordinating and stabilizing business in its various relationships. Under it, cut-throat methods of competition are condemned as destructive and are being eliminated by the substitution of codes of fair competition. The relation of business and labor is being more thoroughly defined and stabilized. Business men are being drawn together in a better understanding of the method of accomplishing the purposes of the act. Employment has been greatly increased, and with this increase has come buying power. A wonderful record of accomplishment in the organization work required under Title I has been made by General Johnson.

THE PUBLIC WORKS ADMINISTRATION

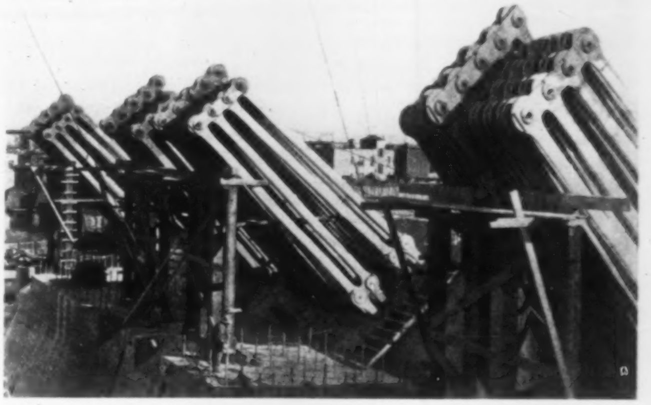
Under Title II is the Public Works Administration, ordinarily designated the PWA. The purpose of this title was to supplement the NRA by further spreading employment and developing buying power through both direct and indirect labor incident to the construction of certain useful public works, as defined in the act. The spread of employment was provided by limiting the permissible hours of labor each week to 30. The act was approved June 16, 1933. The emergency was great; the need was evident; the outline of authority and responsibility had been written. Citizens everywhere were clamoring for public works. Those charged with the administration of Part II of the act found very definite responsibilities imposed by it. These responsibilities could not be discharged without the development of administrative policies and the creation of an adequate organization. To function properly, it was necessary to have a complete organization at the start. The PWA is not a developing organism; it was full grown from the beginning.

Adequate latitude for the expenditure of money for public works was provided. The Federal departments and agencies of government were eligible to receive allotments of money from these funds for public works projects. A determining factor in making such allotments was their relative importance from the standpoint of national planning. The Federal departments and agencies were well organized; their plans were in hand or readily procurable; and the transformation of money into public works, thereby creating buying power through labor, was simple and prompt. Therefore the necessary organization to handle this phase of the work of the PWA was not difficult to develop as a part of the general organization.

NON-FEDERAL PROJECTS

The problem of adequate organization and development of administrative policies in relation to non-Federal projects took time and thought, unless all caution were to be thrown to the winds and all safeguards disregarded. The question arose: What tests will show the eligibility of such projects? According to Circular I, issued by the PWA, the tests may be outlined as follows:

1. What is the relation of the particular project to coordinated planning, and what is its social desirability?
2. What is the economic desirability of the project, that is, its relation to unemployment and revival of industry, and how will it end waste to the community?
3. How sound is the project from an engineering and technical standpoint?
4. Is the applicant financially able to complete the work and reasonably to secure any loans made by the United States?



ASTORIA ANCHORAGE AND ANCHOR BARS OF TRIBOROUGH BRIDGE, NEW YORK
PWA Loan of $42,000,000 Has Been Made Available to Complete Work, Which Was Shut Down in 1932

5. Can the securities to be purchased by the United States or any lease to be entered into between the applicant and the United States be legally enforced?

ORGANIZATION AND FUNCTIONS OF THE PWA

The functions and organization of the PWA are also outlined in Circular I, substantially as follows:

> The act (Title II) requires the performance of three functions: (1) the formulation of the comprehensive plan, which involves determination of the eligibility of any project for inclusion in the plan and ascertainment of the facts as to its feasibility from an engineering, financial, and legal standpoint; (2) the negotiation and drafting of a contract between the United States and the applicant, when the project has been approved by the Administrator; and (3) supervision and enforcement by the Administrator of the performance of the contract.

In order to perform these functions effectually and promptly, the administration is decentrally organized but has centralized control. The central organization is outlined substantially as follows:

TRIBOROUGH BRIDGE ANCHORAGE

LONG ISLAND ANCHORAGE FOR TRIBOROUGH BRIDGE
Eye-Bars Protected with Tarpaulins (April 1932)

> 1. The Planning Board advises and assists the Administrator in the preparation of the "comprehensive program of public works" required by the Recovery Act. This is accomplished through the preparation, development, and maintenance of comprehensive and coordinated plans for each regional area, in co-operation with national, regional, state, and local agencies. The plans are based on surveys and research concerning the distribution and trends of population, land uses, industry, housing, and natural resources; and the social and economic habits, trends, and values involved in development projects and plans. An analysis of projects for coordination in location and sequence is made by the Planning Board to prevent duplication or wasteful overlapping and to obtain the maximum amount of cooperation and correlation of effort among the departments, bureaus, and agencies of the Federal, state, and local governments.
>
> 2. The Labor Board will advise and assist the Administrator as to the requirements of contracts in so far as they affect labor. This board will function in cooperation with the Department of Labor.
>
> 3. The Board of Review will consider projects referred to it by the Administrator which are approved by him in principle but which are of an unusual character, involving difficult questions of engineering, finance, or law. To it also will be referred projects of a controversial character, for the hearing of objectors.
>
> 4. Units of central organization are set up with appropriate technical personnel for the consideration of the following classes of projects: (*a*) Federal; (*b*) projects of public bodies (other than housing); (*c*) housing; (*d*) private, that is, those of public facilities operated by private corporations devoting their property to a public use, and limited-dividend corporations for the protection and development of forests and other renewable natural resources; and (*e*) railroad maintenance and equipment for approval by the Interstate Commerce Commission.
>
> 5. Engineering, legal, and financial units are set up to serve the PWA as a whole.

STATE ORGANIZATION

In each state it was necessary to organize under decentralized control. For this purpose a State Advisory Board of three members and a State Engineer (PWA) were appointed for each state. Their functions and duties may be outlined as follows:

> The functions of the State Advisory Boards are: (1) to stimulate the submission of projects; (2) to inform the public of the classes of projects eligible for the benefits of the act; (3) to elicit from applicants the supporting data (social, engineering, legal, and financial) necessary for the consideration of a project; (4) to consider the project from the standpoint of local coordinated planning, social and economic desirability, provision of employment, diversification of employment, and engineering soundness; and (5) promptly to submit to the Administrator, with its recommendations, all projects considered.
>
> State Engineers (PWA) have certain general duties. Each is appointed and directed by the Administrator and is responsible to him. In addition he is the executive officer of the State Advisory Board; he organized its office and employs and directs its personnel. He also receives, records, and examines all applications and reports to the board on each application from the standpoints stated in items (3) and (4) in the preceding paragraph.

REGIONAL ADVISERS

For further coordination, the United States has been divided into ten regions, over each of which a Regional Adviser has been appointed. His functions are outlined substantially as follows:

> 1. The Regional Adviser will assist the Planning Board to formulate a plan for each region. In such formulation he will consider state plans. The Planning Board will advise and assist the Regional Adviser in each case, and he will accumulate, collate, and submit to the board all available information useful to it.
>
> 2. He will endeavor to stimulate, by publicity and otherwise, as far as may be within his power, public interest in regional and general planning.
>
> 3. He will obtain from the State Advisory Boards of his region lists of projects under consideration by them and a copy of their recommendations and rejections. He will from time to time visit the offices of the State Advisory Boards in his region and will advise and consult with them to the end that their action may be consistent with sound regional planning.

DIRECT GRANTS AND INTEREST RATES

With this general outline of organization and functions in mind, some special provisions and policies may be reviewed. Public bodies, the states, or their political subdivisions, such as counties and cities, are privileged to make applications for loans, subject to the tests of eligibility, at an interest rate of 4 per cent. They are also eligible to a grant, with or without a loan, of 30 per cent of the cost of labor and materials for any project. In other words, a municipality for example, can borrow from the Government on its securities or use money from any other source to construct a project and in either case is eligible for the 30 per cent grant, provided of course that all provisions relating to wage rates, hours of labor, and other special provisions of the PWA are complied with.

The 30 per cent grant can be used for construction costs or to carry the loan for the first few years. It acts as an inducement to undertake useful public works now, under the prescribed standards of hours and wages. The total cost of a project includes many items of expenditure, besides labor and materials, against which the 30 per cent does not apply. The percentage of grant against total cost will generally be about 25 per cent.

Preference may be given to certain classes of public works proposed by public bodies; nevertheless consideration is given to applicants for any class of construction for which legal obligations may be issued. The general tests of eligibility are applied, and in some instances, such as public utilities, stress is placed on the social desirability and economic necessity of the project.

he PWA attempts to maintain a neutral attitude toward all local controversies.

Private projects under the act are not entitled to the 30 per cent grant, and the interest rate required by the Government on such developments is 5 per cent. Loans may be made to private corporations for projects such as bridges, tunnels, docks, drydocks, viaducts, water works, reservoirs, pumping plants, canals, markets, hospitals, when devoted to public use and when self-liquidating in character. Loans can also be made to private, limited-dividend corporations, for the protection and development of forests and other renewable natural resources that are state regulated.

MINIMUM-WAGE RATES ESTABLISHED

In making any loan, the PWA requires the applicant to sign a contract covering the fulfillment of all requirements of the act and the policies of the PWA, as well as the special conditions of the particular loan. As a preliminary to the consideration of projects, it was necessary to establish certain policies. One of the most difficult of these was the question of wage rates. The act, in Section 206, Item (3), provides that "all employees shall be paid just and reasonable wages which shall be compensation sufficient to provide, for the hours of labor as limited, a standard of living in decency and comfort."

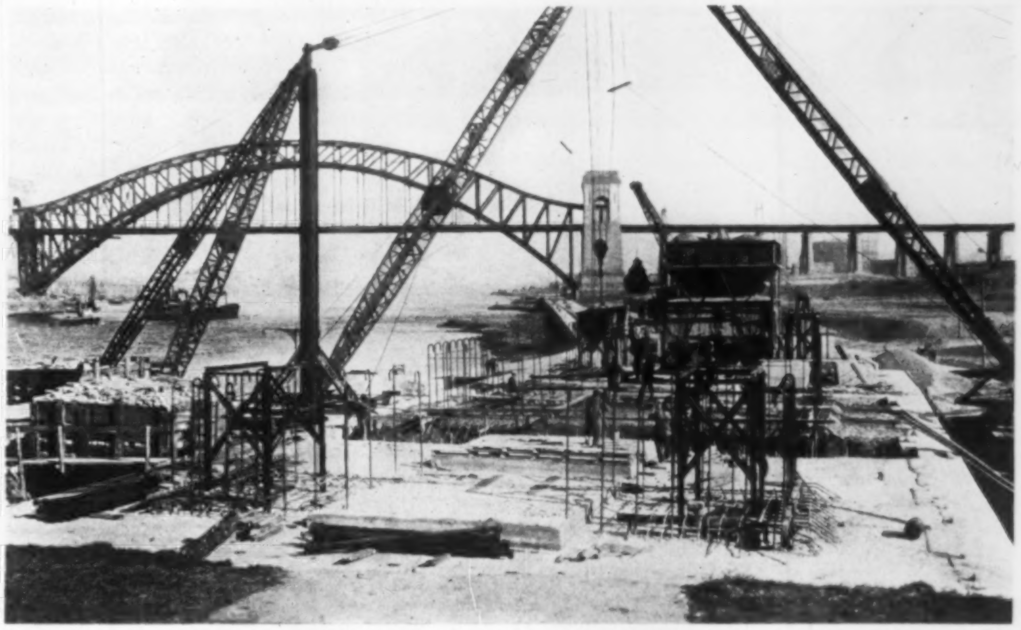
It was necessary that some standard be set up as a basis for the making of estimates. It would cause utter confusion to let each locality in the United States separately attempt to arrive at this conclusion. Accordingly, in conference with representatives of the Department of Labor, the present minimum rates for skilled and unskilled labor were adopted. The United States was divided into three zones, comprising states in the northern, central, and southern sections, within which these minima apply. For skilled and unskilled labor the minimum rates for the southern zone are $1.00 and $0.40 an hour, respectively; for the central zone $1.10 and $0.45; and for the northern zone, $1.20 and $0.50.

Since the hours of work are limited to 30 for each week, it is evident that the weekly income is not excessive. This was not fully appreciated at first. This matter of minimum wage rates, together with other questions involving rates and classifications of skilled and unskilled labor, constitutes a difficult problem, which will be adjusted where necessary by the Board of Review.

Some other problems that have caused difficulties include the question of labor recruitment sources, debt limitations of public bodies, conflicting state laws, and provisions of state constitutions. Some of these questions could be and were quickly solved, but others cannot be solved in time to be of value in the present emergency.

ACCOMPLISHMENTS TO DATE

Now that the high spots of organization, functions, and policies have been covered, mention should be made of the actual accomplishments achieved during the very few months that this act has been in effect. Over $2,700,000,000 of the total sum has been allotted, leaving less than $700,000,000 subject to allotment. It is expected that this amount will be apportioned by January 1, 1934.



ASTORIA TOWER FOUNDATION OF TRIBOROUGH BRIDGE, NEW YORK
The Bridge Will Connect Manhattan, Queens, and The Bronx Over the East River. Hell Gate Arch Appears in the Background

Of the total allotments made, Federal departments and agencies have received over $1,800,000,000, covering approximately 4,000 projects. Some of this was allotted directly by the act, such as the $400,000,000 for public highways which is being expended through the various highway departments of the states. The Federal allotments cover everything from battleships to sewers, from great dams for power and flood-control purposes, costing tens of millions, to buildings to house caretakers in National Parks and Forests at a cost of a few hundred dollars each. This money is being spent in every state in the Union and its various possessions.

Applications for loans or grants on non-Federal projects have been received from every one of the states. On October 27 a total of 2,180 applications were on hand in the PWA offices in Washington. Allotments have been made of over $136,000,000 each week for the past 15 weeks. Every facility is being used to forward this work. Reports indicate that approximately $500,000,000 worth of construction work is under contract, and this amount is increasing rapidly. The number of men put to work directly and indirectly as a result of the expenditure of these funds is reducing unemployment.

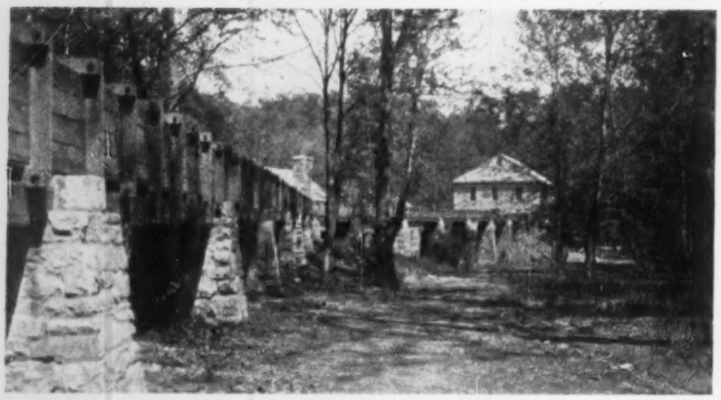
We are just beginning to see the fruition of our labors. As the weeks pass the results will grow more evident, and public works will demonstrate the value of the act as a means of spreading employment and increasing purchasing power.

Restoration of an Old

Century-Old Gristmill with a 24-Ft Overshot

By Oren Reed,
Camp Engineer, Indiana Emergency Con-

FOR the enjoyment of its people, Indiana has created a 1,100-acre park, including the site of the once prosperous village of Spring Mill. When the area was taken over by the state, the only evidences of the village were the stone walls of a gristmill, formerly operated by a wooden overshot wheel to grind flour. After painstaking research and careful measurement of the few remaining pieces of the original machinery, the mill has been reconstructed and put in operation.



Completed Flume, Enclosing the Pipe
Reconstructed Mill in Background

Dressing a White-Oak Axle for the Water Wheel

IN 1817, a gristmill was established at Spring Mill, two miles east of Mitchell, in southern Indiana. The success of the new enterprise was immediate. To provide for increased business and for the comfort of patrons, a number of additional buildings were put up, such as a sawmill, a still house, a tavern, a shoe shop, and a cabinet shop. This center supplied the simple needs of the settlers of the surrounding territory and sent a surplus to Louisville, Ky., and as far as New Orleans.

The three-story stone gristmill was 40 by 60 ft in plan, a huge structure for that early date. Power was supplied to the ponderous stone buhrs by a 24-ft overshot water wheel, to which water was conducted in a wooden flume from Hamer's Branch, a stream emerging from a large cave.

Until the advent of the railroad, the Baltimore and Ohio, the business activity and importance of the Spring Mill settlement increased. After the establishment of Mitchell as a station on the railroad in 1859, Spring Mill village became less and less important, although for a long time the mill and distillery continued in active operation. In the nineties, after having witnessed the changes of a century, the village was abandoned and became the property of the Lehigh Portland Cement Company, which still utilizes the water from Hamer's Cave for its Mitchell plant.

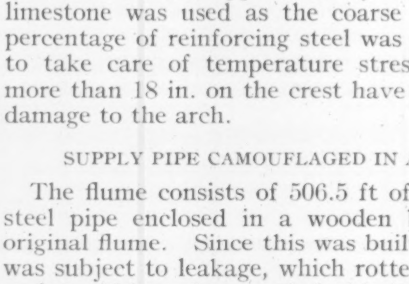
In 1928, the site of this typical pioneer settlement and the surrounding lands, including nearly 1,100 acres, were acquired for a park by the Indiana Department of Conservation. Of the once large settlement only the stone walls of the mill remained in place. The Department of Conservation has now restored more than half the village, including the gristmill.

After the mill building and several surrounding structures had been restored, the water wheel and its supply conduit were built, in the fall of 1931. This step in the restoration required the construction of a small concrete arch dam. The central part of the dam, which is about 6 ft in height, is designed as a true arch, having an upstream radius of 30 ft and a uniform thickness of one foot. The two abutments have a semi-gravity section and are slightly higher than the central part, so that the overflow is confined largely to the stream bed. The dam is provided with two slide gates, a 30-in. sluice gate, and a 21-in. gate for the control of the flow to the flume.

Excavation was carried well into the bedrock, which is Mitchell limestone, by means of air drills and wedges. Explosives could not be used because the bedding planes of this limestone would be badly broken by blasting. In the concrete, approximately a 1:2:4 mix, crushed limestone was used as the coarse aggregate. A small percentage of reinforcing steel was placed on both faces to take care of temperature stresses. Flood flows of more than 18 in. on the crest have been passed without damage to the arch.

SUPPLY PIPE CAMOUFLAGED IN A WOODEN FLUME

The flume consists of 506.5 ft of 20-in. spiral welded steel pipe enclosed in a wooden box to simulate the original flume. Since this was built entirely of wood, it was subject to leakage, which rotted the timber rapidly and would have been undesirable in the park. The new conduit was laid on the old stone masonry piers, which were pointed up and raised to a constant grade. Water flows through the flume to a point just beyond the center of the wheel, pours into buckets set on the wheel's rim, and is carried back to Hamer's Branch through a tailrace.



Secondary Spur Gear and Small Face Gear

Several spans were over 30 ft in length, making it necessary to carry the flume box on the pipe. These circumstances required a pipe that would have sufficient strength to take a heavy superimposed load and still be relatively easy to erect. Span and superimposed load together required a plate thickness of $^1/_4$ in.

Since the water level at the diversion dam could not be raised higher than the base of the Lehigh Portland Cement Company's dam about 100 ft upstream, the total fall from the normal pond level to the lip of the chute above the water wheel is only about 6.1 ft. It was assumed that the water wheel would require 12 cu ft per sec of water when operating at full load. Hence, with a value of 0.013 for N in Kutter's formula, it was computed that a 20-in. pipe would be required.

Special joint couplings were selected which combined strength, flexibility, and durability. In order to relieve the joint and coupling of bending moment after erection was completed, the pipe sections were ordered in such

Water Mill in Indiana

Wheel Rebuilt in Spring Mill State Park

Assoc. M. Am. Soc. C.E.
servation Work Camp No. 2, Indianapolis

The principal subjects treated in Mr. Reed's interesting account are: the hydraulic and mechanical features of the concrete arch dam; the reconstruction of the flume, which carries the water to the wheel; the making of the large wooden gear wheels and their axles, which transmit 25 hp to the original buhr stones; and the rehabilitation of the water-power-operated sash sawmill near the gristmill. The upper floors of the gristmill are occupied by a museum.

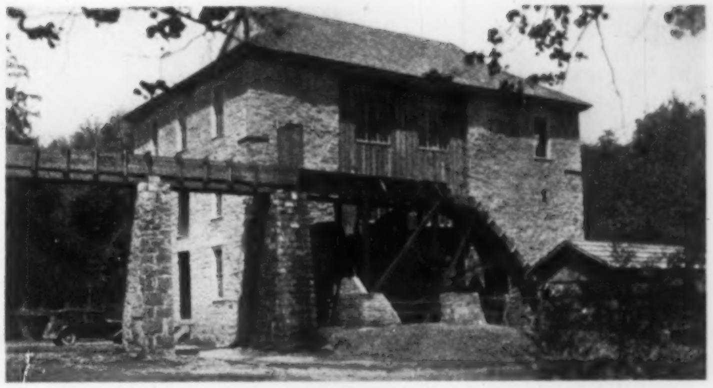
lengths as would make the joint come as near as possible to the quarter point in the span. There are two bends in the line, one of $22^1/_2$ deg and the other of $51^3/_4$ deg. These were given a radius equal to $4^1/_2$ times the pipe diameter in order to secure the best hydraulic properties. Each bend was made by cutting a normal section of pipe on an oblique plane, turning the severed piece a small amount, and welding the circumferential joint.

In the upper part of the line, where the piers were short, the pipe was rolled on to the piers by means of skids and a double block. The pipe was then raised by a small gin pole and shifted lengthwise into its proper place, where it was supported by the gin-pole tackle at one end and by blocking on one pier at the other. After the joint had been made and the coupling bolted loosely, a light A-frame, made of 2 by 10-in. boards crossed and spiked, was placed under the free end, and the gin pole was removed. The section was then adjusted to line and grade with the transit.

Sharpening a 60-In. French Buhr
One of the Original Stones

When erection had progressed down the line to the point where the piers were more than 8 ft in height, the pipe was raised from the ground to its position in the line by the use of a gin pole and a double block operated by a winch. Small tag lines at each end served to steady the pipe during raising. A second gin pole equipped with a chain block was used to support the free end. The chain block was sufficient to raise or lower the free end during the adjustment for grade. By inclining the gin pole by means of the guy ropes, the pipe could be easily brought to the proper line. A crew of from 3 to 7 men erected the pipe in a total of 10 working days.

After this work was finished, the wooden box of the flume was built around the pipe. Approximately 10,000 fbm of native lumber was used in the reconstruction of the box, which is practically a duplicate of the original flume through which water flowed to the first wheel at Spring Mill.


Gristmill and Sawmill Completed
A Museum Occupies the Upper Floors

A Cast-Steel Gudgeon, or Bearing, Being Fitted to the Wooden Axle

Much research work was required for the restoration of the water wheel. People in the community had to be interviewed as to just what the water wheel and the interior of the old mill looked like. Luckily, a section of the rim of one of the original water wheels was found in the drift of Hamer's Branch, about a quarter of a mile away, and from this remnant the dimensions of the wheel could be calculated very closely. In the design, many details were taken from a miller's guide written by Oliver Evans, a once prominent millwright. The first edition of this book was published in 1830, and it was in general use during the period before steam replaced water power.

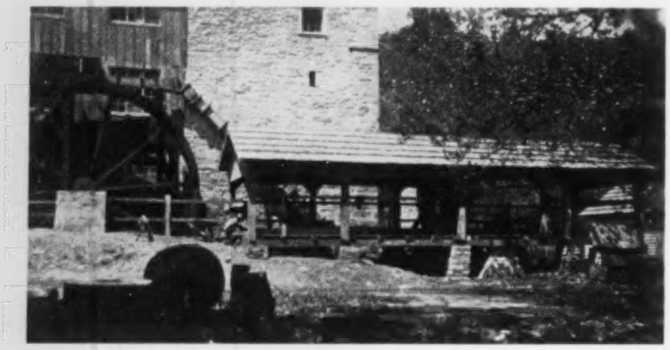
The wheel is 24 ft in diameter and 4 ft in width and has an oak axle 25 ft long and 30 in. in diameter when dressed at the wheel. From the rings it was calculated that the tree from which the axle was cut was at least 195 years old. In the early days it was easy to get poplar trees of sufficient size to make axles for water wheels, but such trees are no longer to be found in Indiana. In the restoration, therefore, white oak had to be substituted. Ten sets of spokes, two spokes in each set, were mortised in the axle. These spokes, 3 by 10 in. in cross section and 11.5 ft long, extend from the axle to the curved rim of the wheel. Sixty buckets, holding about 1 cu ft of water each, were set at an angle in this rim so as to catch the water as it flows from the flume.

Cast-steel gudgeons were used in the rebuilding of the wheel, although cast-iron had been the original material. Also, phosphor bronze bearings were substituted for those of stone or sugar maple. The use of better bearings and gudgeons will make the new wheel last many years more than the old ones did.

Axes and foot-adzes were the tools employed in hewing the axle to dimension. After the axle and other timbers had been framed, they were trucked to Indianapolis and creosoted. The axle was then set in place on the masonry-faced concrete piers and the wheel assembled, as shown in one of the illustrations. The approximate weight of the wheel and axle in operation is 8 tons, and the wheel will develop about 25 hp. Without any gearing, it requires only a small amount of water to run at the normal speed of 8 rpm.

SASH SAWMILL OPERATED BY SEPARATE FLUTTER WHEEL

In the reconstruction the next step was the rebuilding of the sash sawmill just to the north of the water wheel, on the site of the original sawmill, which was operated until about 1885. The new structure was completed in December 1931. Evidence of the site was uncovered while work was in progress on the tailrace for the water wheel. Piers supporting part of the foundation were found and were made use of in the new structure. In preparing plans for the reconstruction, a comprehensive effort was made to secure information from those who remembered the old mill. A number of people could recall its existence, and the design in general was based on the information they supplied, together with construction facts as set forth in the millwright's guide of Oliver Evans.



OVERSHOT WATER WHEEL AND SAWMILL
Supply Conduit for the Sawmill Flutter Wheel Appears Along Face of Building

Water is taken out of the flume just above the overshot wheel and carried in a 10-in. spiral welded pipe to the flutter wheel, which drives the saw. The reconstructed flutter wheel, of undershot type, has a diameter of 4 ft 5 in. and a width of 2 ft 2 in. It has 12 straight buckets set in the rim and is calculated to develop about 9 hp under a head of 26 ft. This wheel is connected, by a $14^1/_2$-in. wooden shaft, to a crank arm. The crank operates a sash in which is set a straight saw blade. This saw has a stroke of about 2 ft and operates at a speed of from 80 to 100 rpm.

METHOD OF FEEDING LOGS TO SAWMILL

Logs are fed into the saw on a carriage 24 ft in length, which is moved inside the sash by two cogways, meshing with cogs driven by a large feed wheel. As the sash and saw move upward, a rocker arm engages the feed wheel, moving it forward one stroke (about $^1/_8$ in.). When small timber is being sawed, the feed may be adjusted to advance the log two notches per stroke. The saw cuts into the log on its downward stroke.

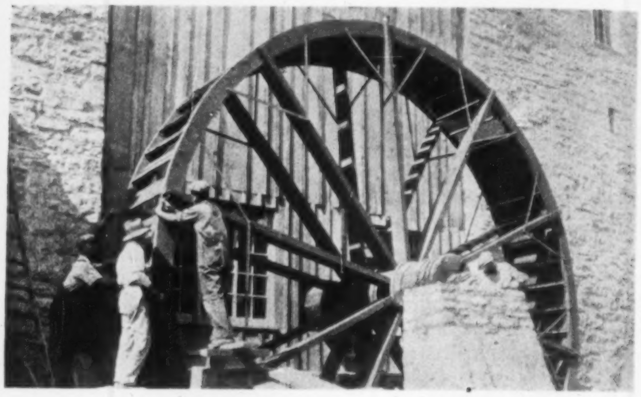
When a cut has been made through the full length of a log, the flutter wheel is automatically stopped by the tripping of the outlet gate, and the water is turned on to a vertical tub wheel, located on one side of the wheel pit. By means of bevel gears and a friction block, the tub wheel returns the carriage to its original position so that another cut can be made. The log is then set over enough for the timber to be cut, is secured in place on the carriage, and the flutter wheel is re-started. The reconstructed mill is housed in an open timber shed, covering the saw and carriage, the roof of which is made of hand-made clapboards. Logs up to 36 in. in diameter have been sawed in the mill.

Some cast-iron gears that had been used in an old sash sawmill near Milroy, in Rush County, were reconditioned and used. Other gears and bearings were cast at a local foundry, using the old gears as models.

In the summer of 1932, a final stage in the restoration of the gristmill was reached when wooden gears were constructed to connect a set of stone buhrs with the 24-ft overshot water wheel. In usual practice such buhrs were placed at the second-floor level of the mill. However, a museum with many relics of pioneer days is housed on the two upper floors of the building, so that it was necessary to keep the machinery on the ground floor.

Power is transmitted from the axle of the water wheel to the wrought-iron spindle, which supports the runner stone, through a series of hand-made wooden gears. These are proportioned so that the speed of the runner is over 98 rpm when the water wheel is operating at its normal speed of 8 rpm. The face gear on the main axle has a diameter of 6 ft on the pitch circle of the wooden pin teeth. Each face gear meshes with a wallower, a squirrel-cage type of gear, the rounds of which serve as gear teeth.

General details of the gear design were taken from Oliver Evans' handbook. Also, a few wooden gears of different types had been assembled in the museum from old gristmills, especially from the Critser Mill near Clifty, Ind. The face gears were made of seasoned white-oak segments, pinned together to form an 8-in. rim, as illustrated. Seasoned timbers 4 in. thick and 16 in. wide were required for the segments of the principal gears. A long search was necessary before such timber could be found. Kiln-dried red and white oak were used for the wallowers and other secondary gears. In places where fully seasoned timber was not required, as in the support framing for the gears, timber cut in the park and sawed in the sash sawmill was used.



ASSEMBLY OF 25-HP WHEEL NEARLY FINISHED
Cypress Flooring Serves as the Bucket Backs

ORIGINAL BUHRS REBALANCED AND USED

A set of 60-in. French buhrs, which were used to grind flour in the original gristmill, was rebalanced, sharpened, and installed to grind corn meal. These buhrs, although over 115 years old, have operated satisfactorily. In operating the mill, shelled corn is put into a storage bin near the south door of the building and is let out as needed into a wooden screw conveyor, which carries it to an elevator. The elevator, in turn, lifts it to a small garner above the buhrs, from which it falls into a hopper and thence to the grinding stone.

Each day during the summer and fall, operation of the mill is demonstrated by the actual grinding of meal. Great interest has been manifested by the visiting public. Small cloth sacks bearing a stenciled sketch of the water wheel and mill were filled with meal, as it was ground, and sold as souvenirs. The meal was sold nearly as fast as it could be ground.

All the reconstruction was designed, and the construction supervised, by the Division of Engineering of the Department of Conservation. I was in direct charge of the work at Spring Mill.

Incomplete Curing Weakens Concrete Surfaces

Series of Tests Demonstrates Variation in Strength Under Different Conditions

By William J. Krefeld

Associate Member American Society of Civil Engineers
Assistant Professor and Engineer of Tests, Testing Laboratories
of the Department of Civil Engineering, Columbia University, New York, N.Y.

FOR concrete the best curing medium is an atmosphere completely saturated with moisture—an ideal unattainable except in the laboratory. The curing processes in general use aim either to prevent evaporation of the mixing water needed for the complete hydration of the cement, or to replace it as fast as it evaporates. To determine quantitatively the effects of improper curing on strength and resistance to wear, a series of tests on specimens cured in various ways was conducted in the testing laboratories at Columbia University. Cores were cut from the specimens, and each successive inch of depth was separately subjected to compression and abrasion tests. According to Professor Krefeld, who conducted the tests, rapid evaporation from unprotected surfaces seriously affects the concrete for a depth of several inches, and may cause loss in strength and in resistance to wear amounting to as much as 50 per cent.

IN the construction of highways, piers, walls, and other concrete structures having large exposed surfaces, it is not fully appreciated that the major loss of desirable physical properties resulting from ineffective curing methods is confined to the material adjacent to the surface and that the loss in strength may be more than half the potential strength of the concrete. Yet it is at the surface that the concrete is expected to provide resistance to wear and weathering agencies. Whatever the other causes of deterioration of concrete may be, the surface effects of inadequate curing are a major contributing cause.

Generally the effectiveness of curing treatments is determined by the resultant compressive strength of cores taken from the structure or of standard 6 by 12-in. cylinders. Such tests are preferred because of the known relationship of the compressive strength of concrete to its other physical properties and the more consistent results obtained for this property. However, these tests can give only a partial measure of the effects of lack of curing.

The problem of curing is essentially one of providing treatments and conditions of temperature and humidity such that sufficient mixing water will be retained within the mass to supply the continued hydration demands of the cement in setting. After initial hardening, loss of water occurs by evaporation from the exposed surfaces. The fracture of a partially dried mass of concrete will reveal moisture in the central part although the edges appear dry. It is doubtful whether all moisture can be removed from the inside of large masses of concrete by capillary action.

Where cores are taken from a highway or, in laboratory investigations, where test cylinders are left in metal molds with only the top surface exposed, evaporation occurs only from the top surface, and its effects are most pronounced in the material immediately adjacent to this surface. In fact, the test cylinder may be considered as composed of concrete with a cap of weaker material at the top, the depth of this cap depending upon the rate of evaporation.

During a recent investigation of the effectiveness of certain surface coatings, conducted at the Testing Laboratories of the Department of Civil Engineering of Columbia University, some studies were made to deter-

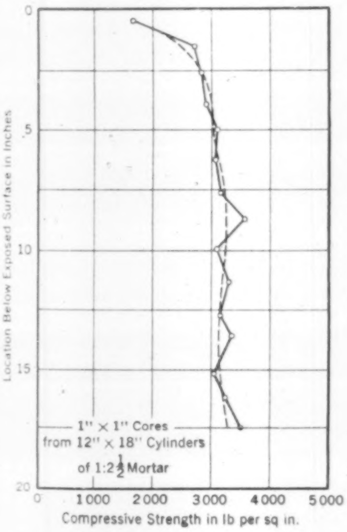


Fig. 1. Compressive Strength of Cores at Successive Depths in a Mortar Cylinder

Cured with Top Surface Untreated and Exposed to the Air at 71F and 69 Per Cent Relative Humidity

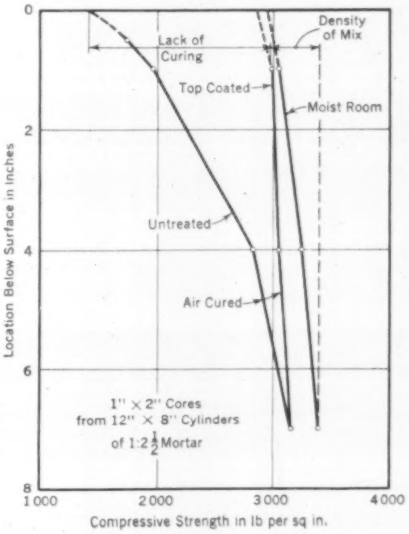


Fig. 2. Average Compressive Strengths of Cores from the Top, Middle, and Bottom of Mortar Cylinders

Detrimental Effect of Incomplete Curing on Top Layers and Beneficial Effect of Increased Density on Bottom Layers

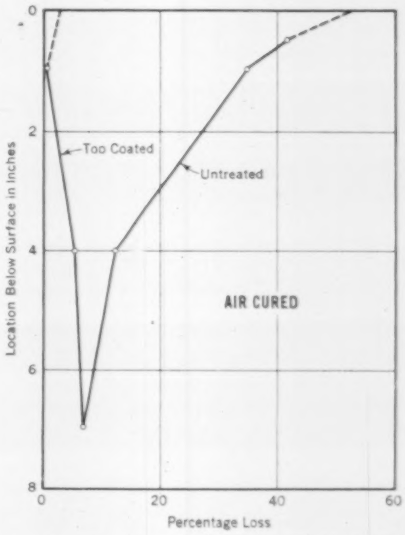
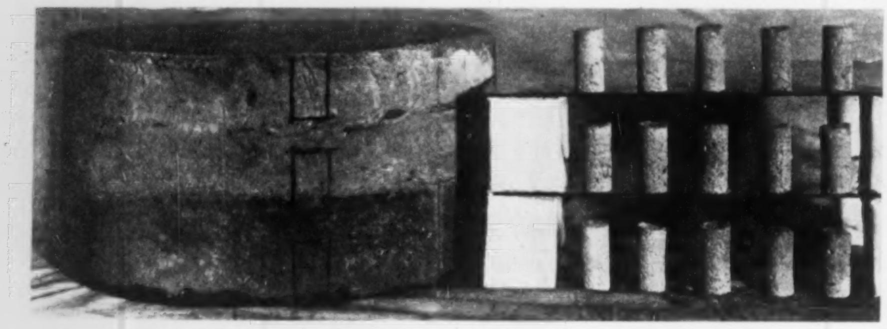


Fig. 3. Percentage of Loss in Compressive Strength in Top-Coated and Untreated Cylinders

Top Layers of Untreated Cylinders Lost About 50 Per Cent in Strength as Compared with Moist-Room-Cured Specimens mine the effects of evaporation of water from concrete and mortar mixes. In addition to the usual compression tests on standard cylinders, tests on mortar cylinders were conducted to study the variation of strength throughout the mass. Inasmuch as curing is concerned with the hydration of the cement, results thus obtained serve as an index of the effects of curing, it being understood that the density of the mix is a factor in the rate of evaporation of the water. Coarse particles were eliminated from the mix to avoid disturbing irregularities in the small core-drill specimens subsequently taken from the cylinders.



CORES 1 IN. IN DIAMETER TAKEN FROM TOP, MIDDLE, AND BOTTOM OF A MORTAR CYLINDER

The Large Cylinder Was Sawed in Three Layers Before Drilling. Surface Irregularities in the Cores Were Avoided by Using Fine Sand in the Mortar Mixed

VARIATIONS IN COMPRESSIVE STRENGTH

Average values for the compressive strength of 1 by 1-in. cores taken at various depths below the surface of a mortar block 18 in. deep are shown in Fig. 1. The mortar, which was mixed in the proportions of $1:2^1/_2$ by volume with a natural sand passing the No. 14 sieve, had a nominal water ratio of 6.1 gal per sack. This block was cast and stored in a sealed metal mold with its top surface exposed to air at 71 F and 69 per cent relative humidity. After it had been stored for 28 days, 75 cores of 1-in. diameter were drilled from the mass normal to the top surface. These were cut to length and faced to provide 1 by 1-in. cylindrical specimens which were tested for compressive strength in a saturated condition. The average curve of variation of strength indicates that a practically constant strength was obtained below 7 or 8 in. from the top surface and that the greatest loss in strength occurred within the top 3 or 4 in. The loss at the top was found to be approximately 50 per cent, as shown in Fig. 1.

In Fig. 2 are shown the results of compressive tests on 1 by 2-in. cores drilled from cylinders of $1:2^1/_2$ mortar, 12 in. in diameter and 8 in. deep. All blocks were cast and stored in sealed metal molds which left the top surfaces exposed. Some of the blocks were stored in air at 71 F and 69 per cent relative humidity, and others were stored in a moist room at 71 F and 100 per cent relative humidity. Similar blocks with their top surfaces coated with four different commercial surface curing compounds were also stored in air.

After storage, 1-in. cores were drilled from the cylinders normal to their top surfaces, cut in 2-in. lengths, and the ends faced, so as to provide specimens from the top, center, and bottom of the block. The results given in Fig. 2 are the averages for the compression tests on these cores, of which there were ten specimens from each location, taken from three sets of blocks. Part of the marked variation in strength at the three different depths is due to the normal variation in the mix, owing to the tendency of free water to accumulate at the top during rodding and placing. It was noted that when blocks were prepared without sealing the bottom of the molds, thus allowing leakage of free water, specimens cured in the moist room showed practically uniform strength throughout their depth. The strength given in the table for the upper half inch is estimated.

In Fig. 3 are shown the same results expressed as the percentage of loss in strength of the top-coated and untreated specimens cured in air compared with those cured in the moist room. The loss of strength at the surface is seen to have been over 50 per cent. The strength throughout the surface-coated blocks approaches that of the moist-cured specimens and indicates the effectiveness of such treatment.

Additional tests on the same mortar cylinders referred to in Figs. 2 and 3 were made to determine relative resistance to wear. Cores 1 in. in diameter were drilled and specimens cut from the top, center, and bottom of the cylinders and subjected to a modified Dorry hardness test. In this test, a constant pressure kept the end of the core in contact with a revolving horizontal disc, on to which Ottawa quartz sand was fed. After 500 revolutions of the disc, the loss in weight and decrease in length of each core were taken as an index of its abrasive resistance. The decrease in length of cores taken from the various blocks is shown in Fig. 4. The increased wear noted is indicated as the percentage of wear on similarly located specimens taken from a block cured in the moist room. The increased wear at the surface of the air-cured blocks was 44 per cent, and there was practically no difference in the resistance to wear of the surface-coated specimens. The decrease in resistance to wear and loss of compressive strength due to lack of curing were nearly the same.

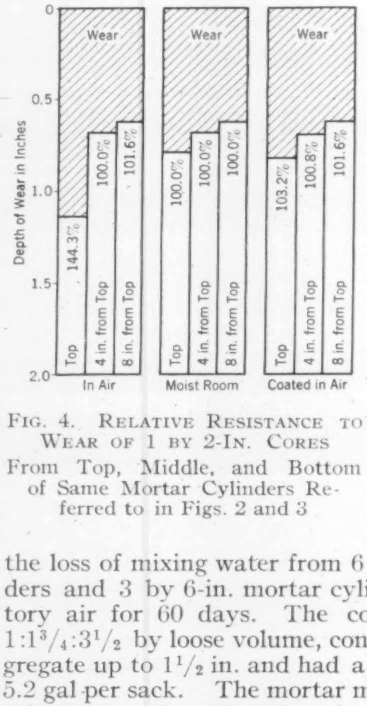


FIG. 4. RELATIVE RESISTANCE TO WEAR OF 1 BY 2-IN. CORES

From Top, Middle, and Bottom of Same Mortar Cylinders Referred to in Figs. 2 and 3

In Fig. 5 is shown the loss of mixing water from 6 by 12-in. concrete cylinders and 3 by 6-in. mortar cylinders exposed to laboratory air for 60 days. The concrete mix, which was $1:1^3/_4:3^1/_2$ by loose volume, contained graded gravel aggregate up to $1^1/_2$ in. and had a nominal water ratio of 5.2 gal per sack. The mortar mix was $1:2^1/_2$ by volume, using a natural sand passing the No. 14 sieve and a nominal water ratio of 6.1 gal per sack. All the specimens were cast in molds sealed against loss of mixing water, and immediately after molding the tops were covered and sealed to prevent loss by evaporation during the first 24 hr. After the molds were removed, the specimens were stored in air at 71 F and 69 per cent relative humidity. They were weighed daily to determine the losses that occurred by evaporation under these conditions.

Similar specimens were treated with a commercial surface curing compound applied with a spraying machine to their tops as soon as the small amount of accumulated water disappeared, and to the remaining surfaces after the sealed molds were removed. In Fig. 5 the losses by evaporation are expressed in terms of percentage of total mixing water used in each set of specimens. These curves represent actual test results for these mortar and concrete mixes, but the general form of the curves is typical. However, the two sets of curves are not strictly comparable because of the difference in the size of the specimens and in the water ratio. These curves indicate clearly that, without protection against evaporation, a very large part of the total water ultimately evaporated is lost within the first few days of exposure. About 40 per cent of the total water lost during 60 days of exposure evaporated during the first day, and about 65 per cent had disappeared at the end of three days.

In many instances the application of treatments used in the field, such as wet burlap, hay, or earth coverings and surface coatings intended to prevent evaporation, is delayed. As a result, their effectiveness is decidedly reduced, since a large part of the water content of the mass has already been lost. The time to start such curing is immediately after the concrete has been poured. In Fig. 5 the evaporation curves for the surface-treated specimens indicate a decided retarding effect, particularly during the early periods of exposure. Some water will be lost because of discontinuity or permeability of the surface film. The effect on the physical properties of the concrete will depend upon the amount of water retained, and whether it is sufficient to supply the demands of hydration.

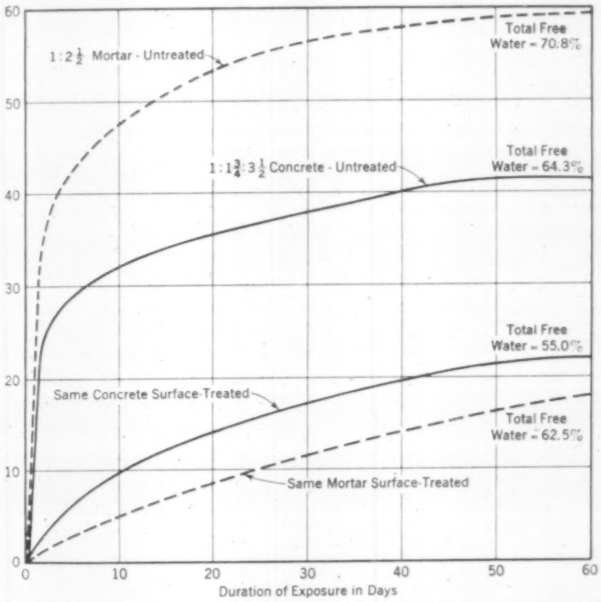
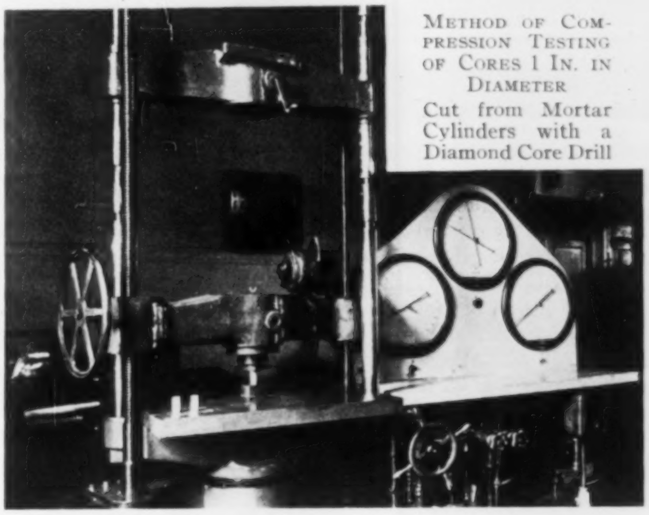


Fig. 5. Effect of Surface Treatment on Loss of Mixing Water by Evaporation

Concrete and Mortar Specimens Exposed to Air at 71 F and 69 Per Cent Relative Humidity

Retention of water in the mass results in a higher percentage of fixed water, that is, water chemically combined with the cement. The amount of this combined water was determined from the known total amount of mixing water and the amount removed by evaporation and subsequent drying at 212 F. The percentage of combined water by weight of cement after 60 days was 16.4 for the unprotected concrete and 20.75 for the more favorably cured, surface-coated specimens. Almost the same values were found for the mortar specimens. In agreement with the absorption values obtained by tests, the percentages of free water, based on the weight of the dry concrete, were 4.49 and 3.81 for the unprotected and surface-treated specimens, respectively. Increased hydration, represented by the larger amount of water combined with the cement, accounts for the improved physical properties obtained by curing.



Method of Compression Testing of Cores 1 In. in Diameter

Cut from Mortar Cylinders with a Diamond Core Drill

Tests at the age of 28 days on concrete cylinders of the mix previously described, and on all surfaces exposed at 71 F and 69 per cent relative humidity, showed a loss of strength of about 25 per cent for those that were unprotected as compared with similar specimens cured in the moist room. It is of interest to note that such surface-coated specimens stored in air showed only a 6 per cent loss of strength when the coatings were applied immediately after molding, and a loss of 16 per cent when they were applied after 24 hr of wet-burlap curing. These results confirmed those of previous tests as to the rapid rate of evaporation during the early periods of exposure. The practice of curing with wet burlap or similar coverings cannot be very effective, especially under conditions of low humidity.

CONCLUSIONS DRAWN FROM THE TESTS

The data that have been presented represent actual results from one series of tests and are of value in that they indicate qualitatively the effects of lack of curing. These effects are more pronounced at later ages because concrete cured under favorable conditions will continue to increase in strength over a long period of time, whereas that hardened with a total lack of curing will show little increase after the 28-day period.

It is of course impossible in most instances to provide ideal curing conditions over a long period of time, but the decided decrease in physical strength and resistance to wear found at the surface of otherwise suitable mixes shows that it is necessary to start curing immediately after pouring and to retard evaporation losses as long as possible. Impervious surface treatments appear to be an effective means of curing. Investigations designed to determine quantitatively the effectiveness of curing treatments must be carried on under carefully controlled conditions, since the effects of temperature, humidity, type of specimen, and condition of specimen at time of test are very pronounced. Compression tests on standard cylinders are not a true measure of the effectiveness of curing.

The Bridge Approach and the Street Plan

Intelligent Planning of Bridge and Tunnel Entrances Reduces Costs and Traffic Delays

By HERBERT S. SWAN
CITY PLANNER, NEW YORK, N.Y.

EVERY highway bridge or tunnel must have adequate facilities for conducting traffic to and from it without delay or inconvenience, up to the full capacity of the structure. Too often in the past neglect of this important consideration has caused bridges to be used to half their capacity or less. A notable exception is the George Washington Bridge, which is served by a carefully planned approach highway net. It should be realized that the cost of obtaining the land for bridge approaches is no mean item, and often amounts to more than half the cost of the bridge itself. According to Mr. Swan, the construction of adequate approach facilities to an existing bridge may well give the same traffic service as the building of an additional crossing, and at a greatly reduced cost. By reference to a number of existing structures he points out the traffic situations that should be avoided in planning approaches to bridges and tunnels.

TO a large extent a bridge can be made to rectify the shortcomings of a city's geography, and in a sense may even remake it. A bridge may obviate the necessity for long detours and thus make two otherwise distant communities near-by neighbors, or even merge them socially and commercially into a single community. It may join an island with the mainland; or it may make a peninsula into an isthmus. It may make possible the development of what would otherwise be a vacant area and permit its utilization by a city's overflow population. Many a section, once a cow pasture, owes its present development to a bridge; indeed, a bridge has often acted the part of Aladdin's lamp to a cross-river community.

How a bridge can reshape a city's environment is well illustrated by the new Bayonne Bridge. Because of its geographical position, at the end of the Hudson County peninsula, between New York Bay and Newark Bay, Bayonne has always been isolated from the metropolitan region. The bridge over the Kill van Kull remedies this defect. Instead of being a peninsula, Bayonne has become, in effect, an isthmus connecting two large bodies of land.

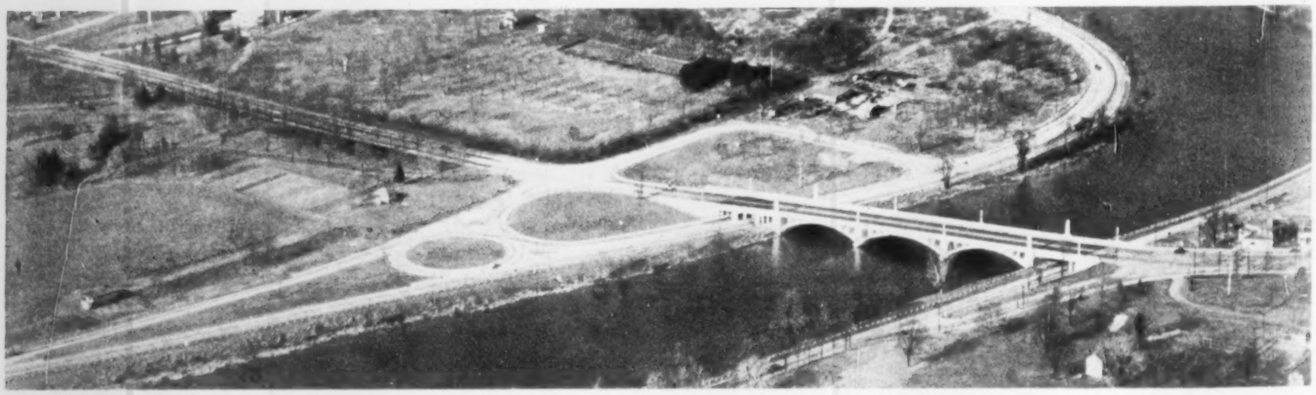
Quite obviously, adequate bridges are of increasing importance to growing communities. As their wealth and population increase, they may reasonably be expected to build additional and more permanent bridges.

NEED FOR ADEQUATE BRIDGE APPROACHES

A common shortcoming that has characterized the construction of bridges in the past, and for that matter still does in the present, is the neglect—the almost supreme indifference—to the approaches. Because of inadequacy in this respect, most of the bridges constructed in the last generation are used, and can be used, only to a fraction of their physical capacity. Nor is this all. Since the traffic bound for such a bridge does not have ready access to it, the thoroughfares in the vicinity are clogged, so that the general movement of vehicles throughout a large part of the community is confused and disorganized.

This situation is usually to be explained by the fact that bridge approaches have almost always been an afterthought in the city plan. The street plan has usually been developed without regard to possible bridge crossings; indeed, when the streets were originally laid out, village conditions prevailed. To have planned at that time for prospective bridge heads would have appeared not only unnecessary but positively ridiculous in its conception of the future needs of the community.

Although engineers today are devoting no more attention than in the past to the development of appropriate approaches for possible bridges to be built in the future, they are at last beginning to apply as much thought and skill to planning the approaches of a projected bridge as to the structure itself. Ideal standards in planning a bridge head would require continuous movement of traffic not only over the bridge but through the approaches leading to and from it. Nowhere would stagnant traffic be permitted. In the construction of the more recent bridge heads, where this ideal standard could not be attained, the emphasis has been placed on securing the maximum flow of traffic across the bridge



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BROADWAY BRIDGE AND GRADE SEPARATION AT PATERSON, N.J.
A Good Example of Approaches to a Bridge of Moderate Cost

coincident with a minimum of congestion at the approaches.

To effect this result, the usual method has been to lay out a large plaza at the mouth of the bridge, in which vehicles can marshall themselves before or after crossing the river. By this means they are kept from cluttering the thoroughfares leading to the bridge. These plazas have another object. At the entrance plaza they feed to, and at the exit plaza receive from, the bridge the maximum possible amount of traffic up to the physical capacity of the bridge. Since the flow on the bridge is unobstructed and is therefore relatively much greater than that on adjacent city streets, the combined width of the roadways entering the plaza should, if possible, be several times that of the roadway on the bridge. Unless this is the case, the bridge will carry but a fraction of its potential capacity.

APPROACHES TO THE HOLLAND TUNNEL

Such plazas have been provided at both ends of the two tubes of the Holland Vehicular Tunnel under the Hudson River, between Jersey City, N.J., and New York, N.Y. The approach plaza on the New Jersey side is an ordinary street widened to 160 ft for two blocks, or about 850 ft. The main exit from this plaza to the New Jersey Superhighway and diagonal bridge across the Hackensack Meadows is by way of a street widened to 100 ft, which hardly deserves the name of plaza. For a distance of four blocks, or about 1,750 ft, the two parallel plazas are about 460 ft apart. At this point, the exit plaza makes two right-angle turns and joins the New Jersey Superhighway. The entrance plaza is a straight projection of the superhighway to the mouth of the tunnel. A big shortcoming is that Jersey-bound traffic must make a left and a right turn to travel the distance of two blocks separating the main tunnel approaches from the superhighway by way of which it leaves the city. Traffic lights are located at each of these several streets, and the cross traffic proves a source of distinct annoyance and delay to all traffic approaching and leaving the tunnel.

At the New York end, the freedom with which traffic approaches the westbound tunnel is remarkable. All traffic is stopped before entering the tunnel for the collection of tolls, but the toll booths are so numerous and are so placed that they can usually take care of the tolls without causing any appreciable delay. The entrance plaza on the New York side occupies an entire city block, or an area of about 170 by 400 ft, exclusive of bounding streets.

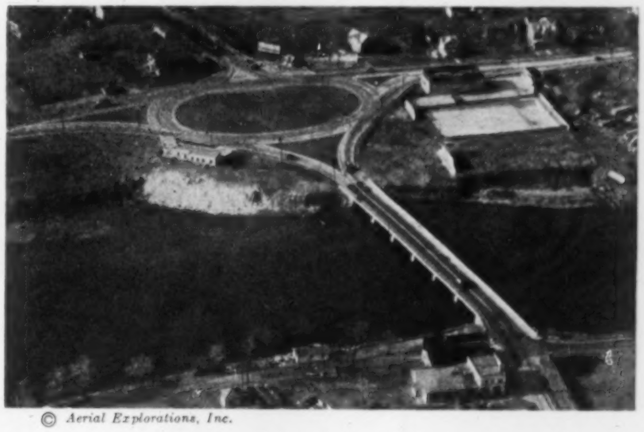
GENERAL CITY TRAFFIC ON SEVENTH AVENUE INCONVENIENCED BY TUNNEL APPROACH REGULATIONS

Real criticism, however, may be made of the arrangement of the streets leading to the westbound tunnel. Seventh Avenue, one of the most important traffic arteries in New York, extends north and south from the Battery to Central Park. Throughout its length it is open to two-way traffic, except for a short distance opposite the tunnels. All southbound traffic, unless it is tunnel bound, is diverted over adjacent streets around the mouth of the tunnel in order that it may continue on its way without interruption. This regulation causes distinct annoyance and inconvenience to general city traffic. Some method should be evolved, by such means as bridges or underpasses, to eliminate the difficulties caused by cross traffic and left turns.

Traffic discharging from the mouth of the New York end of the vehicular tunnel is unable to move smoothly and continuously into the various streets because of the great amount of general traffic utilizing them. Considering the many difficulties involved at this point, however, it is a question whether any more efficient, and at the same time more economical, means can be evolved for the distribution of the exit traffic. The exit plaza embraces a triangular block with sides 140, 200, and 240 ft long, and a strip 62 ft wide by 170 ft long on the west side of Varick Street, which is itself 100 ft wide.

ELIMINATION OF CROSS TRAFFIC FROM THE BRIDGE HEAD

A number of bridges have their effective capacity materially reduced by the heavy cross traffic of major streets immediately in front of, or near the bridge head. Under these conditions the traffic capacity of the bridge is proportionately reduced; frequently the actual capacity may be decreased to 50 or even 40 per cent of the maximum unobstructed flow.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Market Street Bridge and Traffic Circle, Paterson, N.J.
Traffic Regulation Built Into the Circle by Islands

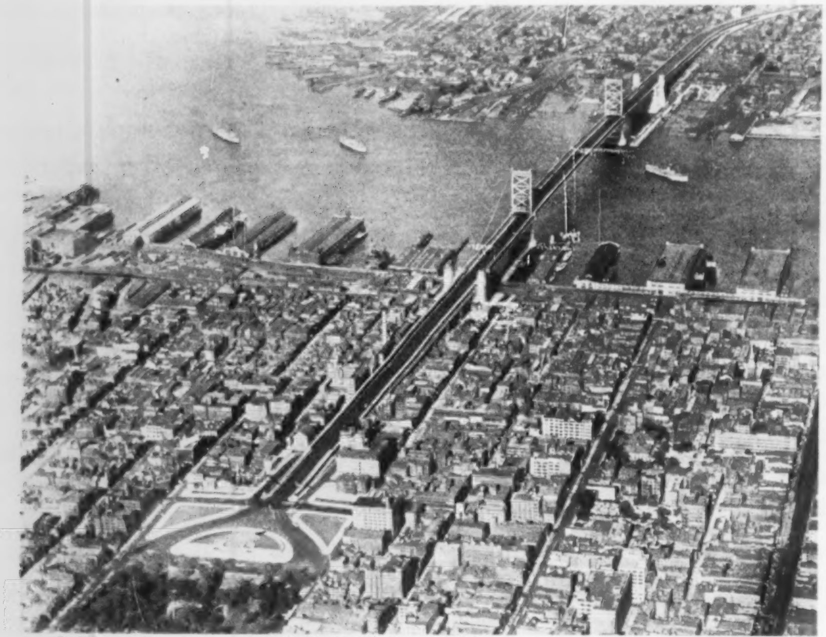
It might be well for some cities, before building new bridges, to have a careful survey made to ascertain whether a reconstruction of the approaches of existing bridges might not so increase their actual capacity as to render a new structure unnecessary. In many cases there is no doubt but that a dollar spent on a traffic circle or on a separation of grades at a present bridge approach would buy more bridge capacity than a similar expenditure on a new structure.

GRADE SEPARATIONS FOR RECENT BRIDGE APPROACHES

For recent bridges, approaches have been designed to avoid intersecting cross streets at grade near the bridge head. Today, in as far as practicable, a separation of grades is effected wherever such streets intersect the approaches. Either the streets are depressed beneath the approaches, or the approaches are placed under the streets. Various degrees of elevation and depression of the two roadways in question are utilized in order to effect this result. In Washington, D.C., for example, a low-level street carries cross traffic back of the Lincoln Memorial and under the Memorial Bridge.

In planning the George Washington Bridge, all left turns were cared for by ramps leading either to overhead crossings or to underpasses, so that all traffic turning to the left leaves or enters the bridge by making a right turn. This device is of the utmost importance, not only in maintaining an unobstructed flow of traffic over the bridge but also in permitting the bridge to carry maximum traffic.

As regards the elimination of cross traffic and left turns at the mouth of a bridge, the Broadway Bridge over the Passaic River at Paterson, N.J., is for a comparatively small bridge probably the best example. New highways recently built parallel to each side of the river pass under the respective approaches to the bridge.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BRIDGE PLAZA AT THE PHILADELPHIA END OF THE PHILADELPHIA–CAMDEN BRIDGE ACROSS THE DELAWARE RIVER

On the west side of the river, two ramps connect Broadway, which crosses the bridge, with the highway that passes underneath. As a result, all cross traffic and left turns are eliminated at the west bridge head; both are shifted to the roadway below. On the east side of the river only one ramp connects the bridge roadway with the underpass, and some left turns, though not many, are necessary.

APPROACHES TO PHILADELPHIA–CAMDEN BRIDGE

In the case of the Philadelphia–Camden Bridge over the Delaware River, the Philadelphia Plaza occupies the entire block, 530 by 720 ft in area, bounded by Fifth, Sixth, Race, and Vine streets. Through the plaza, through Fifth Street and the two streets parallel to the bridge alongside the masonry abutments, the bridge roadway, 57 ft wide, is served by six surface roadways with a combined width of 413 ft, all devoted exclusively to bridge traffic. Traffic on Fifth Street, which formerly crossed the mouth of the bridge at grade, proved so obstructive that this street has now been placed in a subway under the entrance to the bridge The six roadways serving the bridge exclusively are exceedingly important in that they enable it to receive much more nearly its capacity load than would otherwise be possible considering the congestion in the streets surrounding the plaza.

The Camden Plaza occupies the block between Sixth, Penn, Seventh, and Linden streets in Camden, an area of 330 by 460 ft. Traffic to and from south Jersey enters and leaves the plaza via Broadway, and that to and from New York and Atlantic City by two one-way streets. The traffic on these two streets is merged in the parkway beginning east of the Cooper River, whence it proceeds for almost two miles to the Kaighn Avenue Circle, where it is redistributed to different state highways. There are neither bridges nor underpasses at the Camden end of the bridge to separate left turns and cross traffic from the main stream of bridge traffic. It would seem just as desirable to separate the grades of the plaza and Sixth Street in Camden as those of Fifth Street and the plaza in Philadelphia. An underpass on Sixth Street, Camden, permits pedestrians to cross the plaza without obstructing traffic.

TRAFFIC CIRCLES AS DISTRIBUTORS OF BRIDGE TRAFFIC

In some places the traffic circle is being called into service to deliver and distribute bridge traffic. But it should be remembered that such a circle can in no sense perform the functions of a plaza. It is not a storage reservoir for vehicles, but rather a roadway for the automatic and continuous distribution of moving traffic among several roadways having a common intersection. A traffic circle as a means of providing reservoir space will almost always prove disappointing. Special care must be taken in surveying the collecting and distributing facilities for traffic at a bridge head to provide appropriately for its specific traffic needs.

An oval traffic circle has recently been constructed at the Boston end of the Charles River Dam. This circle has a maximum outside diameter of about 350 ft and an inside diameter of roadway varying from about 170 to 230 ft. The planning board desired to carry the cross traffic under this circle in an underpass, but as yet this has not been done.

Within the past year or so a traffic circle has been constructed in Boston at the mouth of the Longfellow Bridge over the Charles River. The inner part of this circle carries five elevated railway columns. It has an inside diameter of about 240 ft and an outside diameter of about 360 ft. To eliminate from it the southbound traffic paralleling the river, an underpass has been constructed beneath the bridge. There is also an underpass for pedestrians across one end of the circle to eliminate interruption of rotary traffic by persons desiring to cross the street.

When the draws are open at the Charles River Dam and the Longfellow Bridge, the waiting traffic congests neighboring streets. Both of these drawbridges illustrate the desirability of a plaza to serve as a reservoir space.

A traffic circle in the shape of an oval, with a width of 165 ft and a length of 300 ft, is located at the west end of the Market Street Bridge over the Passaic River, at Paterson, N.J. This circle, which has a minimum roadway width of 40 ft, is eccentric to each of the two cross streets. Traffic islands at each entrance to the circle direct traffic in the proper channels. This circle functions exactly as any traffic circle at a street intersection might function. In appearance it is far more satisfactory than a grade separation, which was contemplated originally. Underpasses beneath a bridge are a different matter from grade separations constructed in front of it, which are very apt to disfigure the bridge structure.

As regards planning of new thoroughfare facilities to secure easy distribution and fluid movement of traffic to and from a bridge, the New Jersey approach to the George Washington Bridge over the Hudson River constitutes the highest achievement to date. Nothing has been left undone to secure the most perfect control over traffic. Probably no bridge approach anywhere in the world even begins to equal this one in its efficient provision for every traffic need.

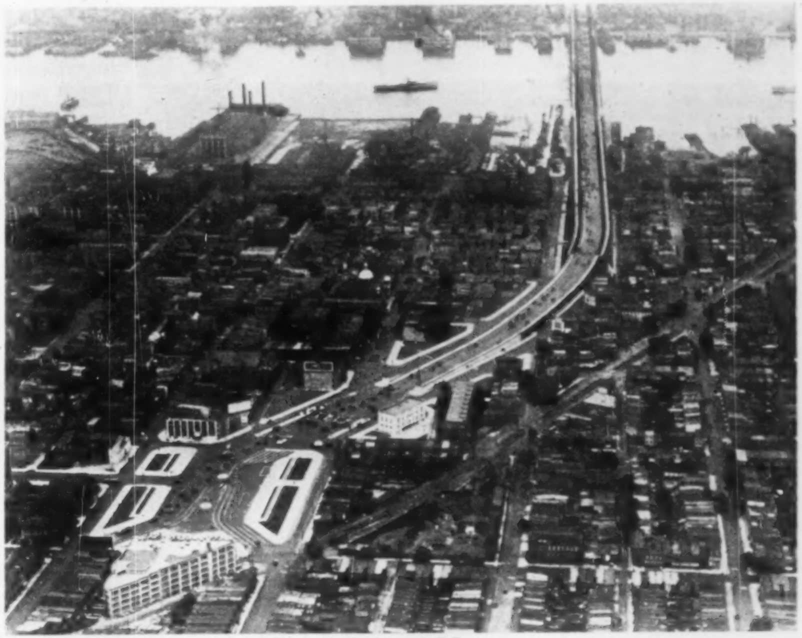
The highways serving the bridge are unique in the sense that they were built for the express purpose of carrying bridge traffic. Although to an increasing extent they will become great regional highways for traffic between different parts of the regions they traverse, the bridge afforded the excuse for their construction. There are no grade crossings for miles on two of these routes, so that the bridge approaches may be considered as extending to the ends of these superhighways, a distance of ten miles and more.

At the New York approach the problem was very different. It involved, not the planning of new thoroughfare facilities, but the adaptation of existing streets to the requirements of traffic to and from the bridge. In New Jersey, the principal highways serving the bridge were built expressly for that purpose; the bridge was their terminal. In New York, on the other hand, every such thoroughfare was already in existence. In New Jersey the thoroughfares were designed and built to serve as bridge approaches; whereas in New York the bridge approaches had to be designed and built so that they could be competently served by existing streets. The problem on the New York side was in this sense far more difficult than that in New Jersey. Yet the imagination, the vision, and the inspiration that the engineers brought to the task, as evidenced by the results, calls forth unstinted admiration. However, it is hardly to be expected that the New York approaches will ever be as efficient in serving traffic as those in New Jersey. There had to be too many compromises with hard facts; yet considering the difficulties to be overcome, it is questionable whether the New York approaches are not as perfect a piece of traffic engineering as those in New Jersey.

COST OF BRIDGE SITES

In New Jersey the approaches to the George Washington Bridge involved the acquisition by the Port Authority of 106 parcels of land costing $1,002,784, and in New York of 50 parcels costing $8,576,775. With salaries, expenses, taxes, and assessments, the bill for land in the two states reached a total of $9,862,000, exclusive of the area purchased by the State Highway Commission of New Jersey. In New York City, the land acquired included an aggregate of four city blocks built up solidly with substantial five- and six-story apartment houses, and embracing nearly 13 acres.

The new highway routes built by the Highway Commission of New Jersey wholly within that state and within ten miles of the bridge, cost an additional $40,000,000. Those in New Jersey within ten miles of the Holland Tunnel, but not overlapping the bridge routes, cost an additional $30,000,000.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CAMDEN PLAZA OF THE PHILADELPHIA–CAMDEN BRIDGE
Traffic Storage Reservoir and Toll Booths

TABLE I. COMPARATIVE COST OF LAND AND STRUCTURE FOR SOME MONUMENTAL BRIDGES

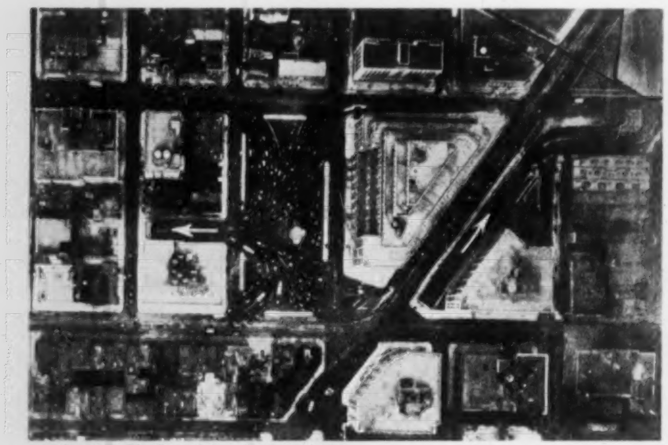
BRIDGE	YEAR OPENED	COST IN MILLIONS OF DOLLARS		LAND COST IN PERCENTAGE OF STRUCTURE COST
		Land	Structure	
Brooklyn	1883	7.1	16.1	44
Williamsburg	1903	9.1	14.2	64
Queensborough	1909	4.6	13.5	34
Manhattan	1909	12.5	14.1	88
Camden	1926	11.3	25.5	44
George Washington	1931	9.9	38.0	26
39th Street Tunnel	1938 (under construction)	17.0	58.0	29

Few people realize the great outlays made for land on which to build the anchorages, abutments, ramps, and plazas demanded by mammoth bridges. Many think of a bridge as solely a structure stretched across a body of water; they seldom consider the land occupied by it. Yet the cost of acquiring the site for a bridge is often nothing short of amazing. Who would realize that in many cases, as evidenced by Table I, the cost of the land approximates the cost of the structure itself? The sums there given include only the cost of the land; nothing is included for improving the streets.

DIFFICULTY OF FIXING BRIDGE LOCATIONS

Much as we may bemoan the fact, it has been practically impossible, and probably always will remain so, to incorporate approaches and plazas for the larger bridges in a city plan many years in advance of their construction. Even if the most desirable locations for such structures could have been foreseen, who would have had the foresight and imagination to plan present-day approaches? In the light of changing traffic needs, of the tremendous progress made in the design and construction of titanic bridges and tunnels, no less than because of their prodigious cost, crossings over or under the larger rivers must be planned at the time the structures are built.

Yet such considerations need not apply in the case of smaller streams. Also, the date when crossings over smaller rivers will be needed can be more nearly approximated. Present planning for such structures is justified although the same planning for much larger and more expensive structures would be nothing short of absurd. Even here, an eye must be had to the prospective character of the bridge. If its function is principally to carry local traffic, it may perhaps be located in or very near the heart of the business district. But should the primary use of the bridge be for through traffic, then it should ordinarily be placed to one side of the business section, so as not to clog the downtown streets with unnecessary traffic.



Courtesy The Port of New York Authority

ENTRANCE AND EXIT PLAZAS, NEW YORK END OF HOLLAND TUBES

In some cases the site for a prospective bridge can be best anticipated through the establishment of a long, narrow park extending back a satisfactory distance from the water front, to provide sufficient space for the piers, anchorages, abutments, underpasses, and ramps, as well as for an adequate plaza at the bridge head. Such parks, not less than, say, 200 ft wide, may be tied in with the thoroughfare plan through the use of comparatively short radial streets, so as to relate the prospective approach organically to a large region, if not to all the city.

Contrary to the usual view, it is not essential to locate every bridge at the terminus of an existing traffic artery. It is not only feasible, but in many instances very desirable, to develop entirely separate arteries to serve a bridge. Every bridge results in a considerable redistribution of traffic. Provisions for this redistribution must of course be made either before or after the bridge is projected. Obviously, to do this afterwards is exceedingly expensive.

PERTINENT FACTORS IN LOCATING A BRIDGE HEAD

The location of the two ends of a bridge should be conditioned by the present and prospective commercial importance of the river served. If the stream is at present non-navigable and will remain permanently so, then the bridge head may be located close to, if not on, the water front. But if the water to be bridged is navigable, then the bridge head should be located sufficiently far back from the water to permit the construction of the necessary approaches with satisfactory gradients to serve the bridge at the desired clearance height. If a drawbridge is to be built, the bridge head need not necessarily be any further back from the water than if the river were non-navigable. If the river is flanked with high, precipitous banks, the bridge head may, of course, be quite near the water, even on a navigable river. Consideration must obviously be given to the width of the river and foundation conditions. All such facts are of moment in determining the location of a bridge head in the city plan.

A more liberal provision for future bridge approaches in the thoroughfare plan will redound to the great benefit of a city, and it will greatly reduce the cost of future bridge construction. With more adequate approaches, one bridge incorporated as an integral part of the city plan will perform the services of two or three bridges constructed as afterthoughts. The saving effected in the cost of land will in such cases permit the construction of two bridges instead of one. The civic benefits secured through the opening of new residential areas, the distribution of population over a larger region, the development of new traffic routes, and the relief of congestion throughout the city, are all matters well worth while.

Consider the relationship of a bridge approach to the use of the neighboring region The premature obsolescence of buildings and resulting destruction of real estate values brought about by the construction of a bridge in an area that has been built up without regard to the location of the structure, form part of the cost of the bridge, even though they do not appear on the balance sheets. The George Washington Bridge is a magnificent structure; but in another sense it is also a horrible monster. Speculation in vacant land; general relaxation of the zoning regulations protecting private homes; the opening up of large areas to apartments and stores, perhaps generations in advance of any legitimate demand for such zoning changes—all these evils have followed the location of the bridge at that site. Together they have probably cost the home owners of Bergen County, New Jersey, more money in depreciated real estate values than is represented by the structural cost of the bridge. These hidden and unseen costs in bridge building can be obviated only through comprehensive city planning.

Courtesy The Port of New York Authority

ENTRANCE PLAZAS AND TOLL BOOTHS AT NEW YORK END OF HOLLAND TUBES

Bridge approaches should be one of the major features of every city plan since they are so closely concerned with the movement of heavy traffic. They should be merged with, and made an integral part of, the main thoroughfares of the surrounding region. A bridge serving as a gateway to a community across a river should obviously be related to the thoroughfare plan of the entire area that it accommodates. Not only should all cross-river traffic be able to reach the bridge and depart from it quickly, it should do so with the minimum of interference to other traffic. To effect this result predicates a comprehensive city plan, of which the bridge approaches form an organic part.

Problems of Fishway Construction

Fish Ladders, Elevators, Mechanical Screens, and Electrical Fields at Dams and Intakes

By Shirley Baker, M. Am. Soc. C.E.
and U. B. Gilroy, Assoc. M. Am. Soc. C.E.
Engineers, San Francisco, Calif.

After hatching at the headwaters of a stream, the young salmon, or "fingerlings," migrate to the sea. When they reach maturity, about four years later, they return to the headwaters of the same stream to spawn, thus completing the life cycle of the species. Without the aid of special devices, the fish are unable to surmount such man-made obstructions as dams, in their struggle to reach their natural spawning grounds; and unless canal intakes are properly screened the young fish cannot safely go down to the sea. The conclusions and recommendations as to the proper design, location, and construction of fishways, here set forth by Messrs. Baker and Gilroy, are based on their work with the U.S. Bureau of Fisheries during the past five years. They examined practically every existing type of fish screen and ladder in the Pacific Northwest and Alaska; they designed and constructed several such structures; and they have given advice on proper fishway design to a number of large hydro-electric developments.

If migrating fish, such as the Pacific salmon and the steelhead trout, are to be conserved, efforts must be made to maintain stream channels in a condition which will permit a safe journey both upstream for the mature fish seeking spawning beds and downstream for the young fish hatched in the headwater areas. Man, in his agricultural and industrial development, has placed hazards in the path of such safe and easy migration. Dams across streams may entirely block or seriously retard both the upstream and the downstream journeys. Unscreened intakes to power diversions and irrigation canals may draw downstream migrants to their destruction.

Fish ladders, mechanical handling devices, and fish screens—collectively referred to as fishways—are the structures by which conservationists seek to overcome, at least in a measure, the menace to fish life presented by man-made obstructions.

Fish ladders provide the means by which fish can pass over obstructions in their travel up and down stream. In order that these ladders may function successfully it is fundamental that they be so designed and located as to attract fish. Two types of construction are prominent. One, adapted only to certain sites, consists of a series of pools blasted out of the rock foundation, and partitioned where necessary with concrete walls. The other type consists of a series of built-up concrete or timber pools of more or less regular size, constructed on a fairly regular grade.

An example of an efficient ladder of the rock-pool type is the Oregon City fish ladder at the Crown-Willamette Manufacturing Plant on the Willamette River, Oregon. This ladder has a total height of about 40 ft. The pools are large, some being more than 40 ft wide, and the rise between successive pools in some cases amounts to several feet. When an adequate volume of water flows through this ladder during the migrating season the salmon make the ascent with ease.

One of the most effective fish ladders of the second type now in operation is at the Savage Rapids Dam of the Grants Pass Irrigation District, near Grants Pass, Oregon. It rises about 30 ft, is constructed of concrete, and is laid on a grade of 1 on 8. The pools are 9 ft square and have a minimum depth of 3 ft, and the overfall notches between pools are 3 ft wide by 1.5 ft deep. The entrance to the ladder is properly located in the rough water in line with the overfall from the dam, which attracts the fish—a matter of fundamental importance.

Before attempting to design a fish ladder, an engineer should inform himself from the most reliable sources as to the species and habits of the fish predominating at the site—what channels they use, what flow of water is to be expected at the time of the fish run, the approximate number of fish that will pass in a given time—and then design the structure to fit conditions. Experience has shown that the lower entrance to a fish ladder should be located at or very near the line of the overfall from the crest of the dam. Also, it is essential that the pools and entrances should be of ample size, since migrating fish are timid and will be wary of entering constricted passageways.

For a dam not exceeding about 70 ft in height, the ideal fish ladder has its entrance in the "white" water at the toe and is composed of successive pools of sufficient size, built on a grade not steeper than 1 on 8 up and through the dam, thus forming a part of the dam structure. The flow down the ladder should be regulated by means of gates or flashboarding.

A ladder of the reentrant type, which we designed for the Upper Salmon Falls development of the Idaho Power Company on Snake River, in Idaho, has been specified to the Federal Power Commission and will be provided for in the license for the project. A ladder of this type should be constructed as an integral part of the dam, since the bottom of the ladder is coincident with the toe of the dam, and the ladder extends back into the reservoir as far as required by the adopted slope.

Where a ladder must be constructed at a dam already built, and where therefore the reentrant type may not be feasible, a ladder such as we designed for the Sunnyside Dam (Fig. 1) of the U. S. Bureau of Reclamation, on the Yakima River, Washington, is recommended. The Sunnyside Dam is of the concrete overfall type. From stream bed to crest it has a height of 7.5 ft, which is increased to 10.0 ft by the addition of flashboards, held in position for the major part of the irrigation season. This fishway has operated very successfully in passing the heavy runs of salmon and steelhead which ascend the Yakima. Attention is directed to its location, which is about at midchannel; to the heavy reinforced-concrete construction; to the large size of the pools; and particularly to the 6-ft entrances in the side walls of the lower pool, in line with the water falling over the dam. These side entrances, one of which appears in a photograph, permit fish that have missed the front entrance to the ladder and are working along the overfalling water at the toe of the dam, to enter the lower pool from the side. These entrances are found to be much used by the fish.

Another feature which has been found to add to the efficiency of the ladder is the provision of submerged openings through the walls of the ladder. These permit a fish to swim into the ladder, through successive pools, and finally into the reservoir above the dam without making a jump. These openings are formed by casting sections of tile drain or other pipe into the concrete walls. The ladder is protected from heavy drift by two shear-boom rafts 50 ft long, lashed together in the form of an inverted "V" and anchored in the river just upstream of the ladder. The Sunnyside ladder was installed by the U. S. Bureau of Fisheries in the fall of 1929 at a total cost of $4,800.

FISH LADDER AT THE OREGON CITY DAM OF THE CROWN-WILLAMETTE MANUFACTURING PLANT ON THE WILLAMETTE RIVER, OREGON
Has Broad Rock Pools and a Total Height of 40 Ft

In the case of large developments, the provision of adequate fish ladders may become a major item in the cost of the project. For example, the fish ladders installed at the recently completed Rock Island development of the Puget Sound Power and Light Company, on the Columbia River, in Washington, may be cited. At this dam two large ladders of heavy reinforced-concrete construction have been provided, each 630 ft long and laid on a grade of 1 on 10. The pools are 20 ft wide by 10 ft long and have a minimum depth of water of 4 ft. Flow down the ladders is controlled by a series of 3 by 3-ft screw-stem gates set at various elevations to accommodate fluctuations in headwater level. Fish ascending the ladder pass into the river through these gate openings. Each of these fish ladders, together with its control equipment, is reported to have cost approximately $100,000.

Inquiry is often made as to the maximum height to which a fish ladder can be carried with reasonable hope of successful operation. This point has never been definitely determined, but the feasible limit, based on previous experience, would seem to range from 60 to 75 ft. To transport fish to greater heights it would appear desirable to resort to some type of mechanical handling.

Probably the most progressive steps yet taken for the mechanical handling of upstream-migrating fish at high dams are embodied in the structures built by the Inland Power and Light Company at its Ariel development on the Lewis River, Washington. Here the dam raises the water surface of the river 180 ft. In lieu of fish ladders, which would have been impractical at a dam of this height, the company has provided for the trapping of the upstream-migrating fish at the power-house tailrace, and the ripening, spawning, and rearing of the hatched fish on an extensive scale below the dam.

In this scheme, the feature of principal interest to designers of fishways is the trap pool for collecting the upstream migrants. This pool extends along the downstream face of the power house directly over the tailrace, and entrance to it is afforded by three gates of 10-ft width, which, by means of float control, automatically adjust themselves to the tailrace water level. Water pumped from the tailrace is discharged into the upper end of this collecting pool, in which a hoisting tank is submerged. The fish are attracted by this flow and swim into the tank, which is then hoisted, loaded on to a truck, and transported to the ripening ponds, where the fish are liberated and later spawned.

Several runs of salmon and steelhead have already proved the effectiveness of this type of trapping device. The fish naturally follow up the strong flow in the tailrace and show no hesitancy in jumping over the movable-crest gates into the collecting pool, this action being in every respect as simple for them as passage into the lower pool of a fish ladder.

The cost of the trap pool and hoisting apparatus was approximately $57,000, and the total cost of the fish-protection measures at this dam exceeded $254,000. The company bore all costs and now makes an annual payment to the State of Washington for the operation of the hatchery and appurtenances. All details of the design and construction of the fish conservation works at the Ariel Dam were worked out under the supervision of the Division of Fisheries, State of Washington.

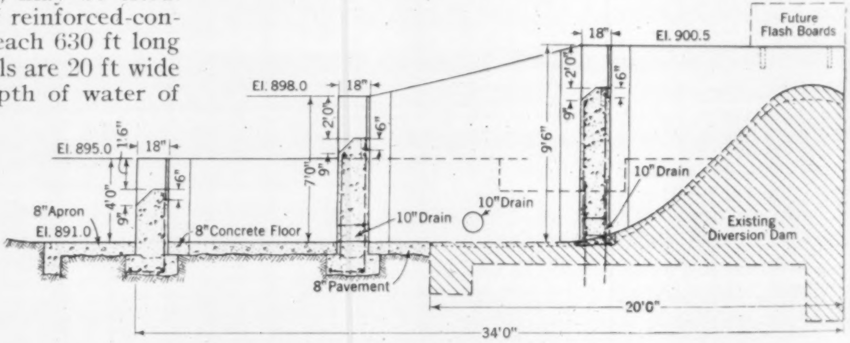


FIG. 1. CROSS SECTION ON CENTER LINE OF FISH LADDER IN SUNNYSIDE DAM, YAKIMA PROJECT, WASHINGTON

An installation for the mechanical handling of both upstream- and downstream-migrating fish has been carefully designed for a development now pending construction in the Pacific Northwest. At this project the dam will raise the water surface of the river 112 ft. The plans for handling upstream migrants at this project call for the trapping and hoisting of fish from the tailrace, as described for the Ariel development, except that the fish would pass directly from the hoisting tank into the reservoir.

Downstream-migrating fish are to be passed from the reservoir to tailwater in the following way. Six intake pipes of 12-in. diameter will pass through the upper section of the dam and connect the reservoir with a stand pipe 8 ft in diameter, on the downstream face of the dam. The intake pipes are arranged to accommodate all levels of the reservoir down to 36 ft below high water. Fish will pass from the reservoir through the appropriate intake pipe and into the stand pipe, whence they will be periodically discharged through an appropriate outlet pipe connecting with an open pool on the side hill behind the power house.

Circulation of water to attract downstream migrants into the intake pipes is provided for without loss of potential power by means of a pipe 18 in. in diameter leading from the bottom of the stand pipe to the turbine scroll cases. To prevent fish from leaving the stand pipe by this route, a float-controlled, wire-mesh diaphragm will be maintained in the stand pipe at the proper elevation. Passage from the open pool to tailwater will be made through a semicircular metal flume, down which water will be periodically discharged.

The mechanical-handling scheme at this location has been worked out by the project engineers in cooperation with the Division of Fisheries, State of Washington, and with the writers.

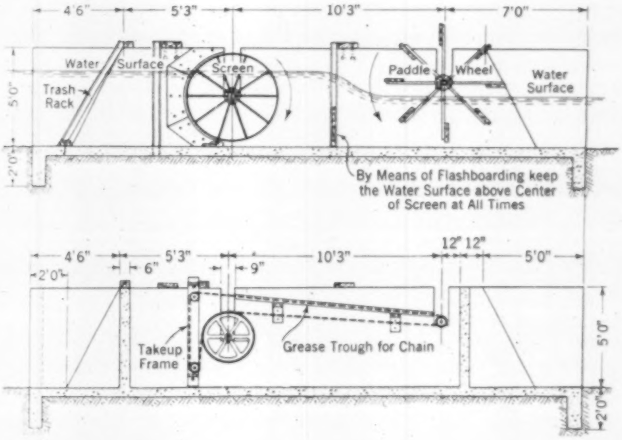
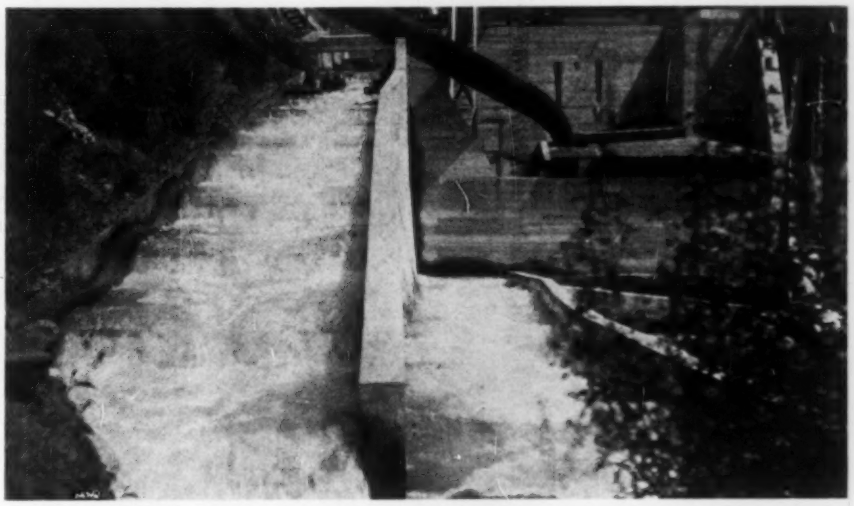


Fig. 2. Revolving Fish Screen and Driving Mechanism
Three Screens 10 Ft Long Were Needed for a Canal with a Capacity of 300 Cu Ft per Sec

In certain localities certain species of fish have been observed to travel largely at night. An interesting occurrence was noted during a count of mature salmon and steelhead trout passing up the Savage Rapids fish ladder during a migrating season on the Rogue River, in Oregon. In order that the count might be continued at night, a powerful light was placed so as to shine on the overflow notch leading into the highest pool of the ladder. The small fry, traveling downstream in schools and attracted by the light, were seen to be caught in the swift water and carried into the next lower pool and so on down the ladder and into the river below. This would seem to indicate that lights properly placed at the upper intake of a fishway will facilitate downstream migration.



Concrete Fish Ladder at the Savage Rapids Dam on the Rogue River, Oregon
Grade of Ladder, 1 on 8; Total Height, 30 Ft

Fish screens may well be treated under two headings, mechanical and electrical. Mechanical screens are used to prevent migrating fish from passing into irrigation and power diversions or similar dangerous waterways. Electric screens have been used by the U. S. Bureau of Fisheries to screen the intakes of irrigation and power diversions, to guard tailrace flows against the entrance of upstream-migrating salmon and steelhead, and to guide upstream-migrating salmon to counting weirs.

MECHANICAL FISH SCREENS

The most practical, efficient, and economical mechanical fish screen that has come to our attention is that developed by the Oregon Game Commission in 1921 and since adopted by the Division of Fisheries of the State of Washington and the U. S. Bureau of Fisheries. When properly installed, this screen is positive in its action. The device is not patented. It consists essentially of a cylinder of heavy wire mesh, placed in an appropriate supporting structure and made to revolve on a horizontal axis in the direction of flow. By means of flashboards placed just downstream of the screen cylinder, the water level on the upstream side is maintained higher than the axis of the screen cylinder. Thus debris coming in contact with the screen rides over the top and is washed downstream. The motive power may be furnished by paddle or bucket wheels placed in the waterway below the screen, or by electric power, as may seem more suitable.

Such a screen should be designed specifically for a given location so that satisfactorily low velocities can be maintained at the screened section. Velocities higher than about 1.8 ft per sec have a tendency to throw the small fish flat against the screen cylinder, in which position they are carried over the top of the screen, thus defeating the purpose of the installation. Wherever this screen is installed to protect migratory fish, an adequate by-pass channel must also be provided so that the fish can return to the main stream. Experience has shown that the proper location for the by-pass opening is at the bottom of the screen box, just upstream from the screen cylinder.

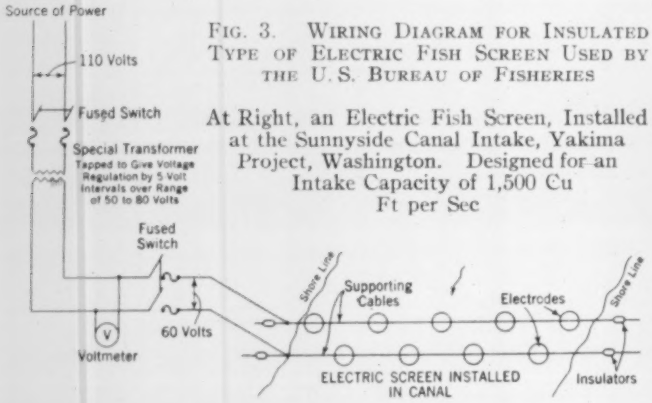
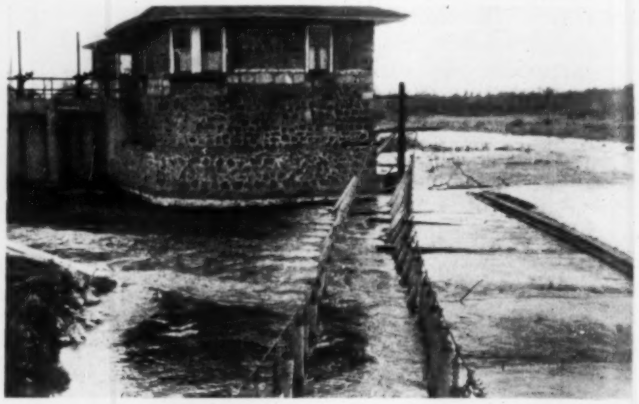


FIG. 3. WIRING DIAGRAM FOR INSULATED TYPE OF ELECTRIC FISH SCREEN USED BY THE U.S. BUREAU OF FISHERIES



At Right, an Electric Fish Screen, Installed at the Sunnyside Canal Intake, Yakima Project, Washington. Designed for an Intake Capacity of 1,500 Cu Ft per Sec

Details of a typical revolving screen for a canal with a capacity of 300 cu ft per sec are shown in Fig. 2. This screen, which we designed, was installed in 1931 by the U.S. Bureau of Fisheries on the Jocko Canal, Flathead Indian Project, Montana. There is nothing to prevent the successful and general use of this type of screen on even the largest canals except, perhaps, the matter of first cost, which mounts rapidly as the size of the screen is increased.

Recently we prepared detailed designs for a screen of this type that has been approved by the engineers of the U.S. Reclamation Service for installation on the now completed Sun River Slope Canal in Montana. The capacity of this canal is 1,435 cu ft per sec. At the site of the screen it has a normal bottom width of 30 ft and a water depth of 11.5 ft. In order to secure sufficiently low velocities at the screened section, it will be necessary to widen the canal to accommodate a screen of five sections, each having a width of 14 ft and a diameter of 13 ft. The estimated cost of this screen is approximately $18,000. If the screen structure could have been incorporated in the canal at the time of its construction, a material saving could have been effected over the estimated cost.

ELECTRIC FISH SCREENS

Attention has been focused on electric installations as a possible means of economically screening large diversions. Experimental work conducted by the writers for the U.S. Bureau of Fisheries has confirmed the early findings of Prof. F. O. McMillan, Research Professor in Electrical Engineering at Oregon State College, that the insulated type of screen, employing a double row of large-diameter pipe electrodes, energized with ordinary 60-cycle alternating current, constitutes the simplest and most effective electric fish screen. This type has been used by the U.S. Bureau of Fisheries in the Yakima country on Government diversion structures having capacities up to 2,000 cu ft per sec. It consists of a double row of pipe electrodes of 6-in. diameter, fabricated from No. 20 galvanized iron, properly weighted at the lower end, and suspended in the water from supporting cables.

As to spacing, the most effective distance between electrodes has been found to be 4 ft from center to center in each row, and 6 ft from center to center between rows. The use of pipe electrodes of this large diameter keeps the voltage gradients around the pipes reasonably low. The wide spacing presents no obstruction to the passing of drift, and the entire installation, being insulated from the ground, is not affected by the conductivity of the channel bed. The screen is electrified with 60-cycle alternating current at a potential ranging from 55 to 80 volts. Convenient voltage regulation is provided by means of an insulating transformer especially tapped on the secondary side and designed to carry a sustained short circuit. In Fig. 3 is shown a wiring diagram and hook-up for an electric fish screen of the insulated type, as used by the U.S. Bureau of Fisheries.

The electric fish screen has been applied to three major problems confronting fish conservation. It has been employed (1) to stop or divert the small downstream-migrating fish from entering irrigation and power diversions; (2) to stop or divert the mature, upstream-migrating fish from entering tailrace waters at power houses; and (3) to guide upstream-migrating fish to some particular location in the channel, such as a counting weir or a hatchery trap.

It appears that, as a means of preventing small, downstream-migrating fish from entering irrigation and power intakes, this device will never be entirely positive as is the mechanical screen of the type described. An electric screen is efficient or not according as it sets up in the water an electric field that will give a fish a shock from which it can quickly recover and escape to the safe waters of the by-pass channel. Many factors unite to make difficult the achievement of high efficiency. The extent and distribution of the electric field set up in the water is influenced by the chemical composition of the water and, in the case of grounded screens, by the conductivity of the channel bed. The fundamental experiments of McMillan at the Bonneville Hatchery proved that the paralyzing effect of the electric current is an inverse function of the length of the fish. Likewise it is known that different varieties of fish react differently when in contact with an electric field.

Obviously, fish of various species and lengths will encounter the electric field, but in field operations it is practical only to have it energized at a voltage that experience has shown, in general, to be effective against the average kind and size of fish present. This means that some fish will penetrate the field farther than others, and these will of course have more difficulty in retreating to safe water. Likewise, some fish will be affected more promptly or more violently than others, and as a temporary paralysis delays their action in moving to safety, the water current will drag these incapacitated fish deeper into the electric field, through it, and down the intake.

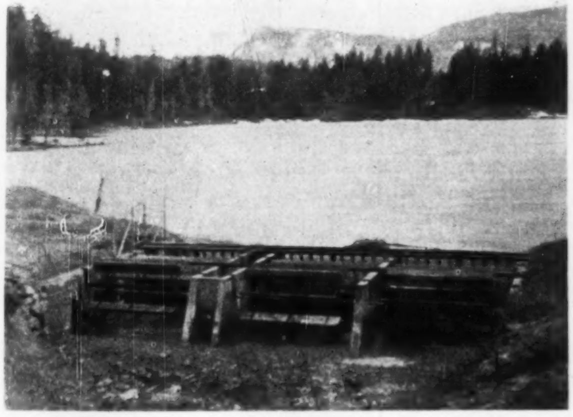
A factor of major importance in the efficiency of an electric screen is the provision of a properly located by-pass channel carrying a substantial flow of water. Without such a by-pass it is evident that the electric screen will not be successful in diverting salmon and steelhead, for these fish feel a tremendous natural urge to go downstream to salt water, and it is reasonable to expect that they will persist in their efforts to find a passage through or around the electrified area until they become paralyzed and are swept down the intake.

Observation of conditions along the streams on which the Bureau of Fisheries has operated electric screens in the Yakima country, Washington, and a very careful check of the fish left stranded in the ditch systems at the end of the irrigation season, would seem to indicate that these electric installations have diverted a substantial percentage of the fish and thereby justified their use at these locations.

An electric screen operated for a period of over two years in the tailrace of the Gold Ray Power Plant, Rogue River, Oregon, has proved that such a screen is practically 100 per cent efficient in preventing upstream-migrating fish from entering tailraces. In a tailrace installation, all the natural factors favor the successful operation of the screen, for if any particular fish persists in its attempt to penetrate the electrified area, the water current will carry it downstream to safety as soon as it is overcome or partially paralyzed.

Fish migrating upstream, when prevented from entering tailraces by an electric screen, must of course be furnished with other means of continuing their journey. For this reason it is important that there should be enough flow in the river channel above the tailrace discharge to attract them into it and thence to the fishway at the dam.

In the summer of 1932, the U. S. Bureau of Fisheries operated with outstanding success an electric screen that was used to divert upstream-migrating salmon to counting weirs. The installation was on the Kvichak River, Alaska. At this location two islands, each about one-half mile long, divide the river into three channels. The electric screen was installed at the lower end of the islands across the central channel, which is too deep and swift to permit of the installation of the usual type of wooden rack and counting gates. The width of the electrified channel was 660 ft. The racks closing the side channels were located at the upper end of the islands and had a combined length of 580 ft.



Revolving Fish Screen on the Jocko Canal, Flathead Indian Project, Montana

At the Outlet of the Lake. Details Are Shown in Fig. 2

The screen was energized with 60-cycle alternating current supplied from a 9-kva generator driven by a gas engine. Approximately 80 v was found to be the most effective potential at the screen, and at this voltage the installation drew approximately 50 amp. The action of the screen in diverting salmon up the side channels to the counting weirs was practically 100 per cent effective. More than 5,100,000 salmon were counted at the weirs; no fish were observed to penetrate the electrified area; and less than 200 were killed or maimed by the electric current. Furthermore, these electrocutions were confined to an area where an eddy current prevented escape to safe water after contact with the electric current.

Fish Ladder at the Sunnyside Dam, on the Yakima River

Side Entrances Are Provided in the Bottom Pool, and There Are Submerged Openings in the Walls of the Ladder for the Use of the More Timid Fish. Details Are Shown in Fig. 1

Letters patent have been granted on electric fish-screening devices to H. T. Burkey of Pasadena, Calif., and to Lin E. Baker, of San Francisco, Calif., each of whom claims that his patent covers the type of screen developed by the U. S. Bureau of Fisheries as here described. For purposes of fish conservation only, Lin E. Baker has granted to the United States and to others whom the United States may designate, a license to use the device covered in his patent. Prospective users of the electric screen should satisfy themselves as to their liability in regard to any patent rights.

One drawback to the use of the electric screen at intakes and in tailraces is the antagonism which is likely to develop in the public mind when some fish are killed or stunned by contact with it. The fact that the screen may be saving a large majority of the fish is not taken into account by the public, which promptly condemns the installation. This creates a problem in public relations, the importance of which must be determined by each prospective user of such an installation.

ACKNOWLEDGMENTS

In conclusion, we desire to make grateful acknowledgment to the following for the generous and helpful cooperation given during the prosecution of this work: F. O. McMillan, Research Professor in Electrical Engineering, Oregon Agricultural College, Corvallis; J. E. Yates, Engineer, Pacific Power and Light Company, Portland, Ore.; I. C. Steele, Engineer, Pacific Gas and Electric Company, San Francisco, Calif.; the various officials of the Federal, state, and county organizations; and the personnel of the several power companies with whom contact was made.

Bronx River Parkway Drive Completed

Provides Direct Connection Between New York and Westchester Parkways

By Arthur V. Sheridan

Associate Member American Society of Civil Engineers
Engineer of Design for the Borough of The Bronx, New York, N.Y.

When the Bronx River Parkway was built a decade ago, the solution of a grade-crossing problem in the vicinity of 233d Street in the Borough of The Bronx, City of New York, was left for future consideration. The elimination of this crossing has just been accomplished. Involved in the project now nearing completion were: a crossing over a river, another under a railroad carrying 300 trains a day, a third serving to pass the new drive under a main highway, and the protection of the roadway against flooding from the river. Mr. Sheridan's description of the problems and their solution makes interesting and instructive reading for every engineer.

Among the many arteries of travel connecting the City of New York with the suburban county of Westchester, is the well known Bronx River Parkway. Following the course of the river from which it derives its name, the parkway, because of the pleasing appearance of structures, the landscaping of adjacent areas, and the elimination of grade crossings, affords a scenic and rapid route for vehicular traffic passing between metropolitan New York and points within the beautiful and rapidly growing county lying to the north. Opened to traffic in 1926, the parkway has attracted visitors from many parts of the world. A combination of careful engineering design and architectural treatment, it has served public officials and engineers as an inspiration and a model for similar developments in divers sections of this country.

A break in the continuity of the parkway at 233d Street, in the Borough of The Bronx, however, detracted considerably from the maximum use of the facilities afforded. As shown in Fig. 1, it was necessary at this point for vehicles approaching from the south to ascend a grade, make a sharp left turn through heavy traffic into 233d Street, pass along this street for a distance of about 500 ft and then, turning sharply to the right, descend to that portion of the parkway leading directly into Westchester County. Traffic in the opposite direction had to contend against similar obstacles, with particularly bad conditions at the approach to 233d Street.

On occasions, more than 12,000 vehicles passed in each direction during a period of 12 hr. Parkway traffic was compelled to cross and mingle with the east and west traffic on 233d Street, an important crosstown highway. The consequent delays and confusion made imperative the elimination of this street as an artery of travel for north- and southbound traffic.

To correct these conditions, the City of New York, in March 1927, approved the proposals of the President of the Borough of The Bronx, as set forth by Josiah H. Fitch, M. Am. Soc. C.E., former Chief Engineer of the borough, and authorized the construction of a direct connection between the separated parts of the parkway. The design and construction of the project were begun in the early summer of 1927. Because of many vicissitudes, such as financial and legal problems, which consumed far more time than the preparation of plans and execution of contracts, the project is but now nearing completion. With the paving of the roadway, the drive was recently opened to traffic, but the landscaping of the adjacent areas remains to be effected.

Approximately 1,600 ft in length, the Bronx River Parkway Drive, as the connecting link is known, has a width of 40 ft and passes over the Bronx River, under the New York Central Railroad, and beneath 233d Street. In general the work consisted of the following: grading, paving, and draining the roadway; constructing two reinforced-concrete arches faced with stone masonry (one over the Bronx River and one under 233d Street); constructing one deck-plate-girder railroad bridge over the new roadway; building retaining walls, abutments, and a stairway; widening and changing the channel of the river; erecting a pump house and automatic signals to warn traffic in case of a flooded roadway; installing electrically operated pumps capable of overcoming a hydraulic head, from the river, of 10 ft; providing lighting facilities and equipment; and landscaping the territory adjacent to the new roadway for its entire length.

The project was, for the sake of expediency, divided into three sections or areas of operation: (1) that between the Bronx River Parkway south of 233d Street and the easterly line of the railroad right of way; (2)

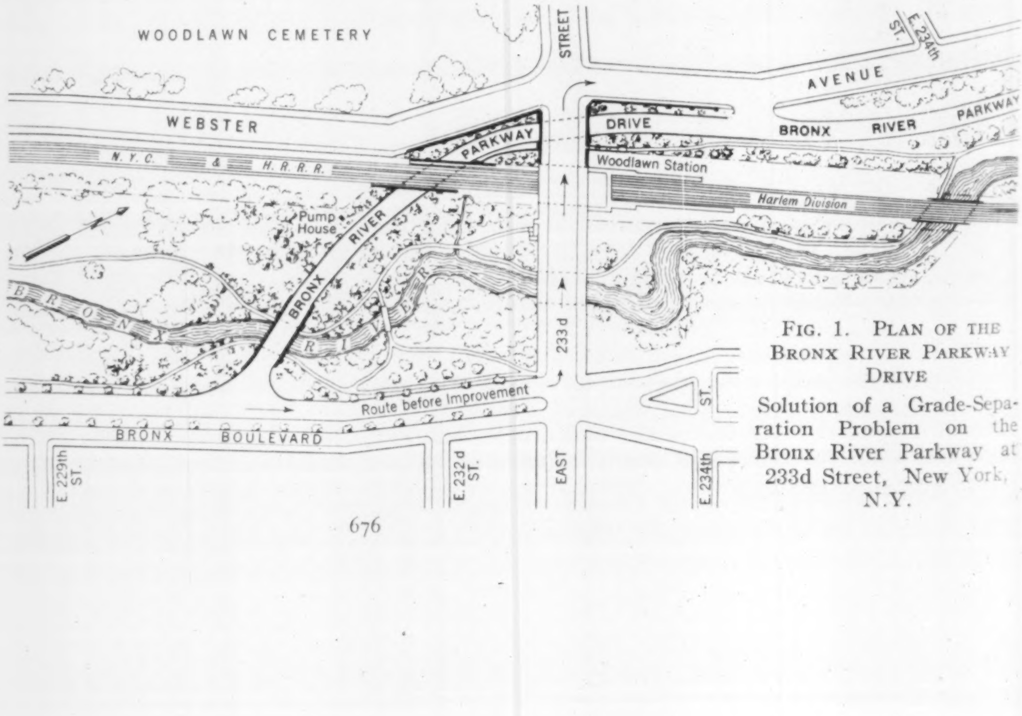
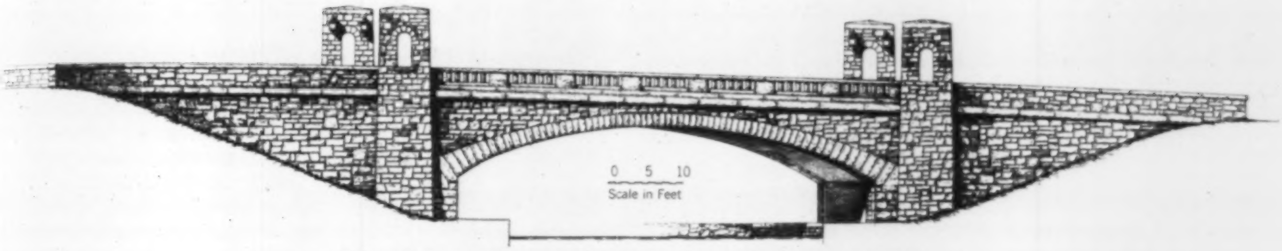


Fig. 1. Plan of the Bronx River Parkway Drive

Solution of a Grade-Separation Problem on the Bronx River Parkway at 233d Street, New York, N.Y.



Bronx River Parkway Crossing Over the Bronx River
Stone-Faced Concrete Arch of 61-Ft Span with 10-Deg Skew

that entirely within the right of way of the railroad; and (3) that between the westerly line of the railroad right of way and the existing parkway north of 233d Street.

CONTROLLING CONSIDERATIONS

Problems presented in the crossing of a river, a railroad, and a highway, together with the necessity for maintaining minimum gradients, determined the route, which was chosen to make the connecting link as attractive as the conditions would permit. The width of the roadway is entirely too narrow. However, there was no alternative, as the parkway into which it led at the northerly end was already built. To have constructed a drive of adequate capacity would have created a throat, and much confusion, where the two roadways met.

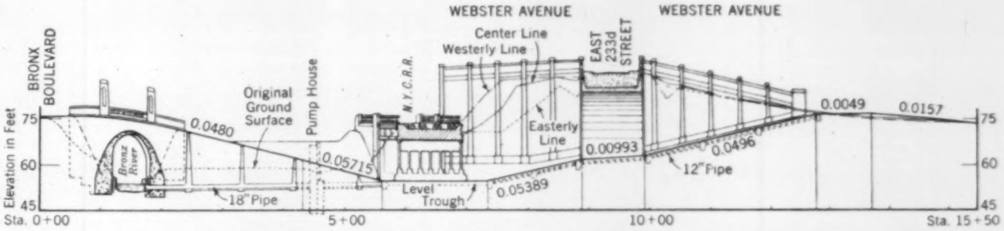


Fig. 2. Profile of the Bronx River Parkway Drive
A River Crossing, a Railroad Grade Separation, and a Street Grade Separation Concentrated Within a Third of a Mile

At the site of the project the railroad carries some 300 trains daily. To maintain an uninterrupted schedule was a consideration of major importance. The problem was further complicated by the proximity of a tunnel whose width precluded any extensive re-alignment of tracks.

Over- or underpassing the river, the railroad, and the highway made unavoidable angular crossings. For the sake of appearances it was desirable that abutments of structures be placed as nearly normal as practicable to the longitudinal axes of structures.

Draining the lowest point of the drive located under the railroad bridge, was the dominant engineering consideration of the entire project. The only available outlet for the water was in the Bronx River. While the amount of fall from the underpass to the river bed is approximately 3 ft, sufficient to install a pipe with a gradient of 0.009, the water level in the river frequently rises to a height of 5 ft, and on occasions to almost 10 ft, above the underpass. A profile is shown in Fig. 2.

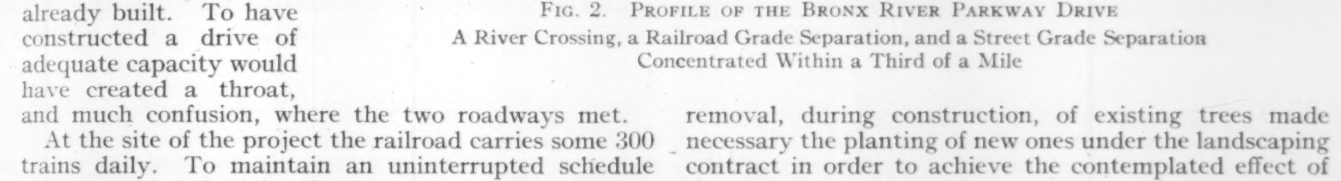
In each instance the type of masonry was selected and the architectural treatment determined with a view to harmonizing the structure, so far as practicable, with the surroundings, when the landscaping provisions should have had opportunity to mature.

The presence of trees, in the vicinity of the Bronx River, suggested the type of masonry and the treatment accorded the arch crossing the river. It was originally intended to face the structures with stone of a greenish mixture, but the cost proved prohibitive, and the use of such stone was abandoned in favor of local granite. The removal, during construction, of existing trees made necessary the planting of new ones under the landscaping contract in order to achieve the contemplated effect of the design.

MASONRY STONE OF HISTORIC INTEREST

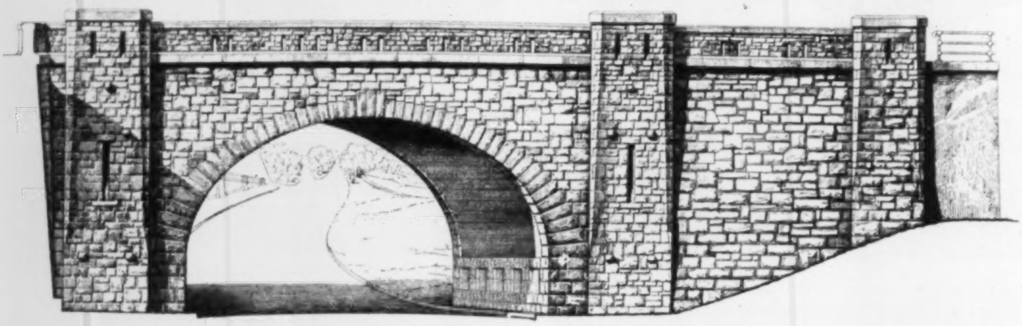
Considerable care was exercised in the case of the 233d Street arch and its contiguous retaining walls. The size and coloring of the ring stones, the type of masonry and other prominent features were fully provided for in the plans and specifications, and the work was executed in such a manner that the completed structure presents an unusually pleasing appearance, especially when viewed from the Parkway Drive itself. It is of historic interest to record that the stone for this arch and the adjacent walls was selected from the dismantled masonry of the famous century-old Highbridge, whose river arches were within the last decade removed and replaced with a single steel span providing waterway clearances demanded by the Federal Government.

The girder bridge, which carries the tracks of the New York Central Railroad over the drive at its lowest point, was originally designed as two flat arches of steel,



New York Central Railroad Underpass at Woodlawn Station, New York
Four Electrified Tracks Carried Over the Bronx Parkway Drive on Deck Plate Girders of 42-Ft Span and 54-Deg Skew: Elevation Is Parallel to Tracks

which were to be faced with stone masonry arches sufficiently separated from the steel structure to be substantially free from the vibrations due to passing trains. The object of this design was to maintain the appearance of stone masonry for all structures, hoping thus to secure a consistent and pleasing treatment for the entire project. However, the problem of draining the underpass, complicated by the requirement of clearance for the roadway and the limited amount which the tracks could be raised, made necessary the abandonment of the flat-arch design and the substitution of an ornamental plate-girder structure consisting of two abutments and a center row of columns supporting a solid steel deck carrying four ballasted tracks.



ARCH OVER THE BRONX RIVER PARKWAY DRIVE AT 233D STREET
Skew Angle, 7 Deg; Span, 40 Ft; and Rise, 15 Ft 9 In.

In the case of the arches and the stairway, balustrades of masonry corresponding with the arch rings and spandrel walls were provided, and in that of the railroad bridge an ornamental iron railing was carried across the span and along the adjacent walls.

The retaining walls are of the cantilever and gravity types. The former are constructed of reinforced concrete faced with square cut stone masonry and the latter of plain concrete faced in a like manner. The maximum height of wall is 36 ft from base to under side of coping. A section of this wall is shown in Fig. 3. Balustrades of cut stone masonry surmount the walls adjacent to streets, and ornamental iron railings, those protecting the railroad embankments.

Except for a distance of 100 ft on each side of the lowest point at the railroad underpass, the roadway, which has a maximum gradient of 0.057, consists of 3 in. of asphalt upon a 6-in. concrete foundation. For the 200 ft referred to, the foundation thickness was increased to 10 in., with steel reinforcement top and bottom. Super-elevations were used on all curves and a concrete dividing strip placed along the center line for the entire length of the drive. Lane markers have also been installed. The electrical work consisted of two phases: first, the lighting system along the drive, bridges, walls, and steps; and second, the pumping and danger signal system.

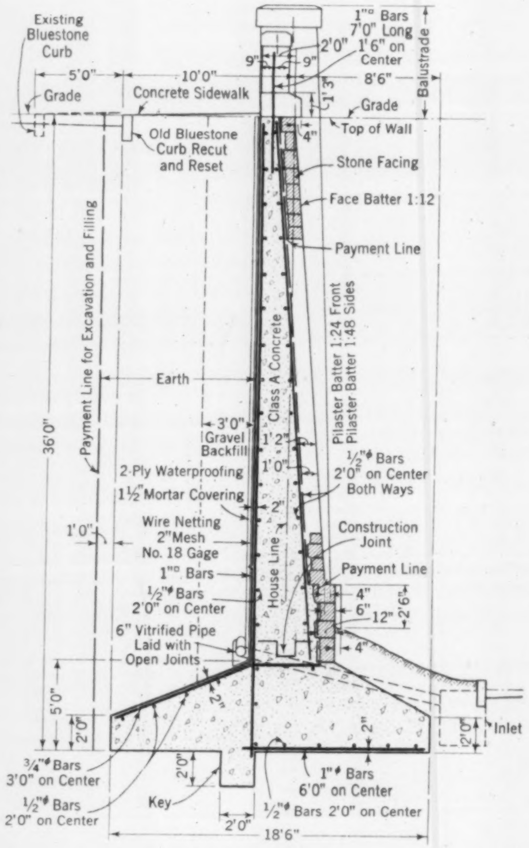

Existing Bluestone Curb
5'0"
10'0"
Grade
Concrete Sidewalk
1"□ Bars 7'0" Long
2'0"
1'6" on Center
9"
9"
8'6"
1'3"
Balustrade
Grade
Top of Wall
4"
Old Bluestone Curb Recut and Reset
Stone Facing
Face Batter 1:12
Payment Line
Payment Line for Excavation and Filling
36'0"
Earth
Class A Concrete
Pilaster Batter 1:24 Front
Pilaster Batter 1:48 Sides
3'0"
Gravel Backfill
1'2"
1'0"
½"ϕ Bars 2'0" on Center Both Ways
2-Ply Waterproofing
1½" Mortar Covering
2"
Wire Netting 2" Mesh No. 18 Gage
1'0"
Construction Joint
House Line
Payment Line
1"□ Bars
½"ϕ Bars 2'0" on Center
4"
6"
12"
2'6"
6" Vitrified Pipe Laid with Open Joints
4"
2"
5'0"
2'0"
2"
Inlet
2'0"
¾"ϕ Bars 3'0" on Center
2'0"
1"ϕ Bars 6'0" on Center
½"ϕ Bars 2'0" on Center
Key
½"ϕ Bars 2'0" on Center
2'0"
18'6"

FIG. 3. SECTION THROUGH THE CANTILEVER RETAINING WALL AT 233D STREET, NEW YORK, N.Y.

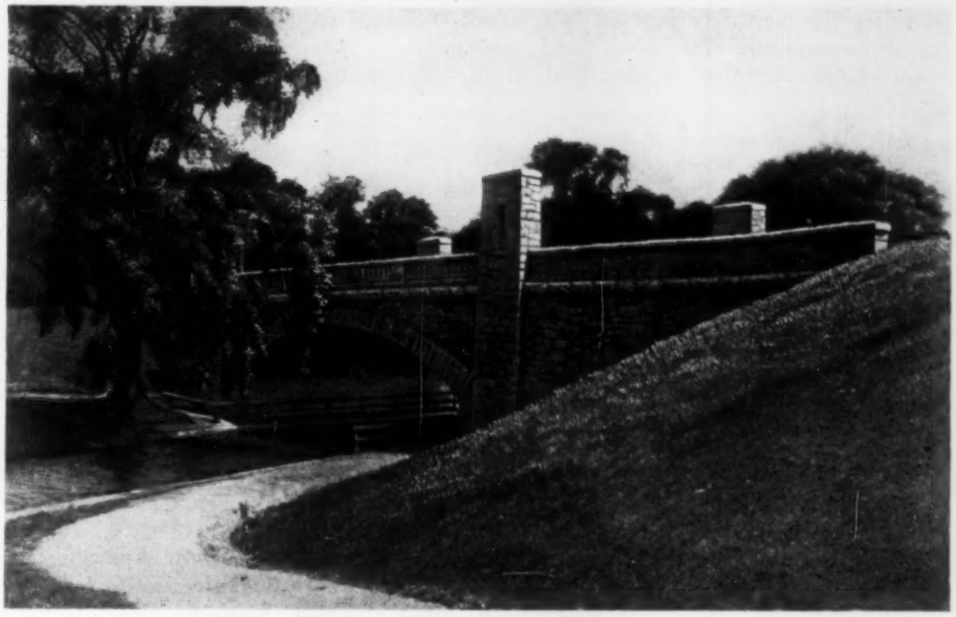
Designs of the concrete structures were based on an allowable stress of 650 lb per sq in. for concrete in compression and 16,000 lb per sq in. for steel in tension. The loadings used were 20-ton rollers, so placed as to produce maximum stresses when combined with dead load and temperature elements. In the case of the railroad bridge, Cooper's E-70 loading with impact equal to $S\left(\frac{30,000}{30,000 + L^2}\right)$ was the basis of the engineering design, which was prepared under the direction of the New York Central Railroad and submitted for the approval of the Office of the President of the Borough.

The concrete arches were designed in accordance with the ordinary elastic theory, with the customary consideration of the various elements which affect, modify, or develop stresses. However, the additional stresses resulting from the slight angular deviation from the normal, of abutments, 10 deg in the case of the river arch and 7 deg in that of the 233d Street structure, while appreciated as existent, were not considered sufficient to justify design in accordance with the skew arch theory.

It was at first believed that a method could be worked out whereby the provision of a pumping system would be avoided. However, the insistence of the Consulting Engineer to the City Board of Estimate and Apportionment that a minimum 14-ft clearance must be maintained for the entire span, including spaces beyond curbs; the proximity of the structure to the Woodlawn Station of the New York Central Railroad, the tracks leading to which were already on a gradient, thereby limiting the amount to which the tracks could be raised to 2 ft 3 in.; and the almost imperceptible natural fall in the river even at low-water stage made provisions for pumping mandatory.

In order to prevent the river from overflowing on to the drive, berms raised to the required elevation were built adjacent to the roadway. The watershed was thus restricted to the drive and adjacent areas within the lines of the embankments. In the determination of drainage requirements, the quantities were based upon the following: rate of rainfall, 4 in. per hr for a period of 10 min.; run-off, 80 per cent of rainfall. A design based upon an economic balance between requirements and capacity called for a pump capale of discharging 2,000 gpm against a hydraulic head of 10 ft.

Pumping equipment is housed beneath the embankment adjacent to the drive and is hidden from view. Access to it has been provided for by means of inclined steel doors. The plant consists of two motor-driven centrifugal units, two three-phase vertical motors, and three floats, together with foundations, fittings, accessories, and other appurtenances. The pumpauto matically commences to operate when the water level in the well reaches a point 5 ft below the lowest point of the roadway.



Arch Bridge on the Bronx River Parkway Completed
Special Attention Will Be Given to Landscaping

CONSTRUCTION DIVIDED INTO FIVE CONTRACTS

Actual construction comprised five contracts. Contract No. 1 included the work located entirely within section (1) previously described: changing the course, and widening the channel, of the Bronx River; constructing an arch over the river; building the roadway; providing adjacent embankments, and installing portions of a drainage system. Contract No. 2 called for relocating a high tension system; raising and realigning a four-track electrified railroad; constructing a girder bridge, abutments, retaining walls, roadway and drainage provisions, together with all other necessary work, except paving, within the limits of section (2). Contract No. 3 consisted of excavating the roadway cut, which in some places exceeds 35 ft in depth; constructing an arch, retaining walls, and stairway; relocating a sewer and a water main; building the roadway, and installing lighting fixtures and drainage requirements—all within section (3). Contract No. 4 comprehended the performance of all work, except that of landscaping, required to complete the entire project. Contract No. 5 provides for landscaping, retouching existing work, and building minor structures throughout the entire project. All, excepting the landscaping contract, have been completed and the drive was opened for traffic on August 14, 1933.

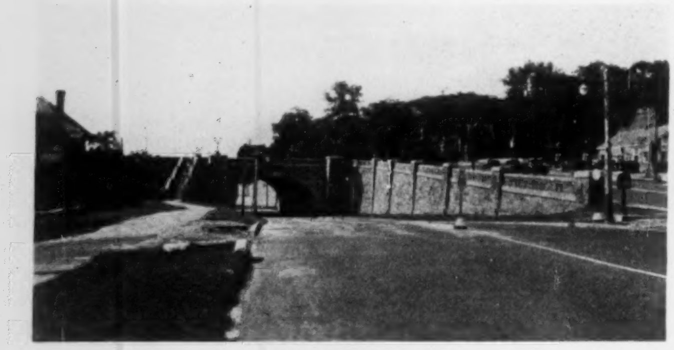
New York Central Railroad Underpass on the Bronx River Parkway Drive
Concrete Dividing Strips and Flexible Lane Markers Direct Traffic

Foundation conditions at the river arch presented the frequently encountered problem of placing abutments on materials of different carrying capacities. After investigation and consideration of various methods it was decided to place reinforcement in the bottom of the footings of the abutments and to spread them so as to bring the pressures within the determined capacity of the soils upon which they rested.

As can be seen by reference to Fig. 1, the Parkway Drive passes under the railroad at a point about 300 ft south of 233d Street. Due to the proximity of the existing bridge carrying that street over the railroad, and of a retaining wall adjacent to the westerly track and just south of the underpass, the distance which the tracks could be thrown laterally, in either direction, was very restricted.

Because of the difficulties involved in moving and adjusting the tracks, relocating the high-tension system, and maintaining a heavy train traffic without interruption, the railroad very properly insisted on performing all the work within its right of way. Inasmuch as the railroad, which was compelled to pay part of the cost, was to prepare the plans and execute the work in a manner satisfactory to the Borough of The Bronx, collaboration between both units was necessary. The splendid cooperation of the designing engineering staff of the railroad with that of the borough merits acknowledgment.

As a means of maintaining railroad traffic during construction, the scheme first decided upon consisted of a temporary pile and timber trestle to be erected 15 ft east of the existing easterly track, upon which were to be placed temporary tracks connected at each end with the permanent rails by means of 3-deg curves. However, after the piles for the northerly half of the trestle were in place, it was found impossible to drive those for the southerly portion to a depth sufficient to permit excavation for piers and abutments. This condition necessitated a modification of the original plan. The tracks were in consequence first moved 10 ft to the west and carried on caps and stringers supported by piles driven into the existing embankment. It was then possible to carry out the original scheme, of detouring to the east, by excavating and placing sills and bents at points where piles could not be driven to a sufficient depth. After all four tracks were in place upon the trestle, the abutments and piers were built.



233D STREET ARCH AT WOODLAWN STATION, FROM NORTH
High Retaining Walls and Station Stairs Complicated the Design

Piles would not penetrate into the cemented gravel material on which the southerly abutment was to be placed. This gravelly soil pitches toward the north, so that at the bottom of the northerly abutment a layer of water-bearing fine sand and clay covered the gravel. The impracticability of excavating, because of the piles supporting the tracks, made necessary the use of steel sheet piling along the front of the abutment and wing-wall footings. This sheeting was anchored to the footings with bolts set in concrete. In order to reinforce the sheeting, two rows of batter posts, 3 ft on centers, were driven. Concrete for the abutments and piers was then poured. The former were faced with native granite in order to conform with other parkway structures. On completion of the masonry features, the steel was placed and the tracks restored to approximately their original alignment.

Flow through a large water main in 233d Street had to be continued without interruption while relocating the pipe in the roof of the arch. This requirement, together with the necessity for maintaining traffic on the street, especially important because it affords direct access for fire engines to a large developed area lying east of the river, provided the only problems in connection with the construction of the northerly structure. The arch was poured in sections and one-half the roadway maintained constantly open.

The total cost of the project to date is approximately $600,000, divided as follows: Contract No. 1, including the Bronx River Bridge, $125,000; Contract No. 2, the railroad bridge, $155,000; Contract No. 3, the 233d Street arch and the adjacent high retaining walls, $260,000; Contract No. 4, the paving, pump house, and ornamental lighting system, $60,000.

Landscaping, which is still to be effected, has been made the subject of careful study with a view to securing the most possible with the available funds. In order to assure the direct services of experts it was decided to separate, so far as was practicable, the landscaping from other phases of the work by making of it a separate contract subject to special restriction and supervision. Such procedure will prevent general or paving contractors from attempting landscaping, either directly or through subcontractors as part of a major contract. The accompanying sketch, Fig. 1, indicates the treatment which has been decided upon and approved by the Landscape Architect of New York and the Department of Parks.

Included in the landscaping contract are the construction of several wing walls and the treatment of the soffit of the 233d Street arch. The accompanying photographs do not indicate the final conditions, as no landscaping has as yet been effected. The estimated cost of this contract is $18,000.

ACKNOWLEDGMENTS

Those who directed the planning and construction of the project include: Major General Elmore F. Austin, Chief Engineer of The Bronx; Edward W. Wood, Deputy Chief Engineer; Egbert V. Lawrence, Assoc. M. Am. Soc. C.E., Engineer of Highways; Raphael J. Smyth, M. Am. Soc. C.E., Assistant Engineer of Design; Thomas B. Dyer, Assistant Engineer in direct charge of the construction; Ernest F. Fox, Assoc. M. Am. Soc. C.E., Assistant Engineer in immediate charge of the design; and the writer, who is in charge of the design of structures and the preparation of plans, specifications, and contracts for the borough. Mr. Fox and Mr. Dyer, especially, contributed to the results obtained, the esthetic features and architectural design being personally developed by Mr. Fox.

233D STREET ARCH FROM THE SOUTH
Woodlawn Station and Tracks of the New York Central Railroad at the Right

The engineering design of the railroad structure was made under the direction of H. T. Welty, M. Am. Soc. C.E., Engineer of Structures, New York Central Railroad, and Z. H. Sikes, M. Am. Soc. C.E., Assistant to Mr. Welty. C. L. Spaulding, M. Am. Soc. C.E., District Engineer for the railroad, was in charge of the construction performed under the supervision of the railroad, and W. A. Bogart, who furnished the information relevant to the construction features of the girder bridge, was Resident Engineer for it. The photography is by Joseph F. Hefele, Topographical Engineer, in the Office of the President of the Borough. To all concerned the writer makes acknowledgments and expresses appreciation for the cooperation extended.

Design of Subway Foundations in Philadelphia

Method of Providing Against Uplift and Entrance of Ground Water

By Sheldon A. Keast
Associate Member American Society of Civil Engineers
Assistant Engineer, Department of City Transit, Philadelphia, Pa.

At many places in Philadelphia, subway structures are built with their inverts below the ground-water level. Therefore special precautions must be taken to provide against hydrostatic uplift and to prevent the water from entering the subway. In this article, Mr. Keast explains the steps in design and the practical considerations which modified the shape of the structure. For example, integral waterproofing was omitted and water-tightness secured by using thicker slabs of richer concrete. In bad ground the subway was supported on mat construction or on steel tubes jacked down to rock.

Aside from soil conditions and loads to be supported, the major factor that must be considered in the design of subway foundations is the presence or absence of ground water above the level of the subway invert. Except at railroad and subway undercrossings, and at a few points where subways pass under buildings, the foundations support only the subway structure itself, the backfill (including underground structures), the roadway paving, and the street live load. For depths of cover of 13 ft and over, the street live load is considered as 200 lb per sq ft, uniformly distributed. This live load is based on the distribution of a 50-ton truck. For depths of cover less than 11 ft, a minimum of dead plus live load of 1,400 lb per sq ft is used. In general, therefore, two cases present themselves: first, the case of foundations whose main object is to support the subway, and second, that of foundations which, in conjunction with the floor, must keep out the ground water as well as support the subway loads.

A typical cross section of a two-track Philadelphia subway above ground-water level is given in Fig. 1. Horizontal drains are provided at intervals of about 55 ft to prevent the accumulation of ground water, which may result from the bursting of water pipes. These drains carry the water to the subway drains and thence to the sumps for discharge into sewers. They relieve the hydrostatic pressure in excess of that for which the subway was designed.

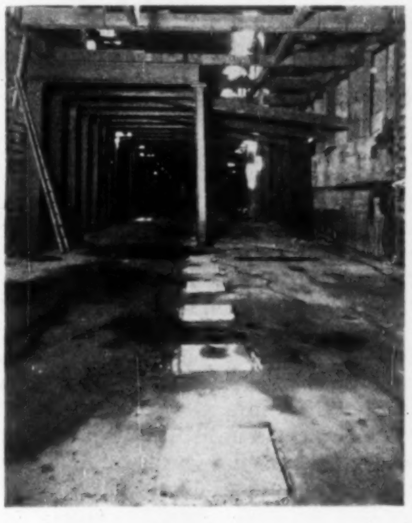
Loads from the roof beams are transmitted to the footings through the concrete walls and steel columns, it being assumed in the case of the side-wall columns that one-half the load is transmitted from the column base to the footing, and the remainder carried by the wall. As the steel bents are spaced 5 ft 6 in. on centers and are spanned by concrete jack arches, the pressure is considered to be uniformly distributed longitudinally. Laterally, the greatest concentration of load is in the vicinity of the columns.

For subway inverts above ground-water level, a 9-in. unreinforced concrete slab is ordinarily used as a floor, on which the concrete-encased ties and the steel rails are laid. This slab, with the track structure, distributes the train load over the subgrade but, being unreinforced, affords little or no distribution of the load from the subway structure.

For the usual soils (sand and gravel) encountered in Philadelphia, the footings are designed for an allowable pressure of 4 tons per sq ft. For medium hard rock, a pressure of 15 tons per sq ft is allowed in the design. If, after excavating, it is found that these pressures are excessive, the footings are redesigned to meet the required conditions.

For a two-track, center-column subway with 30 ft of cover, the approximate load on the side-wall footing is 32,000 lb per lin ft of structure. With an allowable pressure of 4 tons per sq ft, this requires a 4-ft width of footing. Even this depth of cover, which is rarely reached in Philadelphia, does not present a very difficult foundation problem. For cases in which the foundations are on rock, the footings are so narrow that no reinforcement is required even for the deeper covers. In Fig. 2 is shown the relation between the bearing area and the location of the side wall and column. For equilibrium, the centers of pressure must be opposite each other, and the footing, as shown in Fig. 2 (*a*), would therefore produce the distribution of pressure indicated by the trapezoid, the greatest pressure being at the outside of the wall. However, the footings are usually considered as fixed at the walls and are designed as cantilevers, assuming a uniform distribution of pressure, as may be seen from Fig. 2 (*b*). Since the pressure is practically within the limits of a 45-deg line from the base of the column, the deflection of the cantilever would be very slight, and the pressure would be more or less uniform throughout. In order to fix the end of the cantilever and transfer the bending moment to the side walls, bent-up rods are placed in the outside of the walls, as shown in Fig. 2. A width of 4 ft is about the maximum that can be used for a footing without overstressing the concrete on the inside of the wall. Where a greater width is required, the inverts are designed on the same basis as for a crossover, which is explained later. The usual formulas for shear and bending moments are used in the design, bond being usually a major consideration in the design of the reinforcing.

It has been found more economical to design the column footings as isolated where they are spaced $5^1/_2$ ft from center to center, even though they are built continuous, and to omit the upper reinforcement which would be required if a continuous footing were assumed. This also permits the stopping of the footings at


Erecting Steel Bents in a Subway

the middle of a bent, a condition likely to occur at any point, without extending the reinforcing bars to take the maximum positive moment occurring at the center of a continuous beam. These footings have therefore been designed as cantilevers acting about the edge of the base plates. Observation of the subways already constructed indicates that the omission of the rods in the top has caused no appreciable cracks or other signs of overstressing that would call for a change in the method of design.

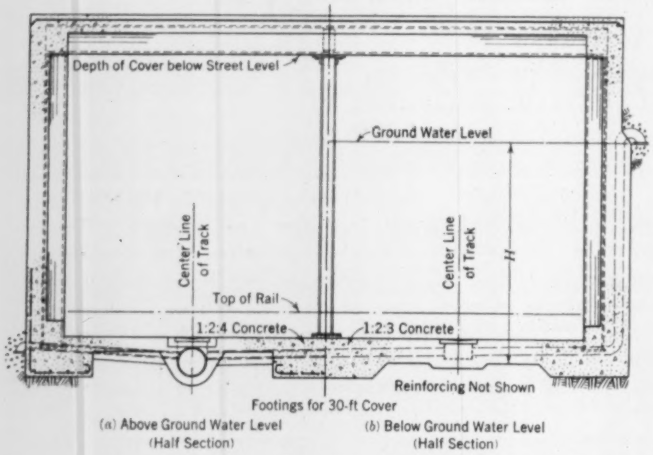


FIG. 1. TYPICAL CROSS SECTIONS OF TWO-TRACK, CENTER-COLUMN SUBWAYS IN PHILADELPHIA

Where the Invert Is Above Ground-Water Level (*a*), and Below Ground-Water Level (*b*)

Ordinarily the roof beams are designed as simple spans. The center-column reaction for a continuous two-span beam is 25 per cent greater than that for the two simple spans. Because of the partial continuity of the roof, brought about by the beam splice plates and concrete construction, the footings of the interior columns will probably receive a somewhat greater load than that for which they were designed, although the increase should not be sufficient to endanger the foundation in any way.

INVERTS BELOW GROUND-WATER LEVEL

The second case, that of a subway invert below ground-water level, is shown in cross section in the right-hand half of Fig. 1. Cast-iron drain pipes 4 in. in diameter are extended downward from the ground-water level to the track drains in the subway. These drains are installed to prevent the building up of pressure in excess of that for which the subway was designed, such as would result from the accumulation of water under abnormal conditions. The inverts are designed for full hydrostatic pressure below the ground-water level. An allowance is made for a 25-per cent increase in the unit stresses in the slabs, because the weight of the concreted track structure reduces the hydrostatic pressure to be taken by the slab and because it is improbable that static pressure to the full head of the original ground-water level will occur except under temporary flood conditions. The inverts have no membrane waterproofing, it having been found that a waterproof structure can be obtained more economically by increasing the thickness of the slab and by using a rich concrete mix, of 1:2:3.

In Fig. 3 is given a detail of the construction joints used. It was found that this joint was effective in some cases, although in others considerable leakage occurred. However, when the concrete was properly placed under and around the copper strip, making sure that no voids resulted, the joint was very effective.

In Fig. 4 is shown a typical detail of the invert for a two-track, center-column subway below ground-water level. As the width of footing required for ordinary conditions is such that a uniform distribution of pressure may be obtained within a distance of about 4 ft, the footings for downward pressure are designed on the same basis as those for a subway not subjected to hydrostatic pressure. No advantage would be gained by distributing the loads over a greater part of the subway invert, since this would result in a greater bending moment at the edge of the side-wall column base.

For upward hydrostatic pressure, however, reinforcement must be placed in the top of the slab. The inverts are then designed for loadings similar to that shown in Fig. 4 (*b*). Some inverts have been designed on the assumption that the inflection points occur at the quarter points of the clear span between columns. The computed locations of the points of inflection for a uniform vertical pressure on the invert, without side-wall pressure, were found to be about $^1/_{6.6}$ of the span at the wall and $^1/_{4.44}$ of the span at the center column. When the side wall is considered as subjected to horizontal pressure, they were found to be about $^1/_{3.76}$ of the span at the wall and $^1/_{5.43}$ of the span at the center column. As it is highly probable that the walls will not receive the computed side pressure because of the method of driving steel beams and sheathing during construction to hold back the earth, a ratio of one-fifth of the span at both ends was considered conservative for the design of the invert.

PLACING THE REINFORCEMENT

Reinforcement is placed as shown in Fig. 4 (*a*). Longitudinal reinforcement amounting to 0.002 or 0.003 of the area of the slab is added to prevent shrinkage cracks, which would permit the entrance of water. Owing to the depth of the invert slab, the increase in the thickness under the columns in most cases is small and is computed to be that required to transmit the bending stress at the column, or that required for punching shear. Though later specifications have omitted punching shear in the design of footings, it has been found to form a good starting point for the design of shallow footings. Footings have therefore been designed for a punching shear of 150 lb per sq in. for a concrete mix of 1:2:3.

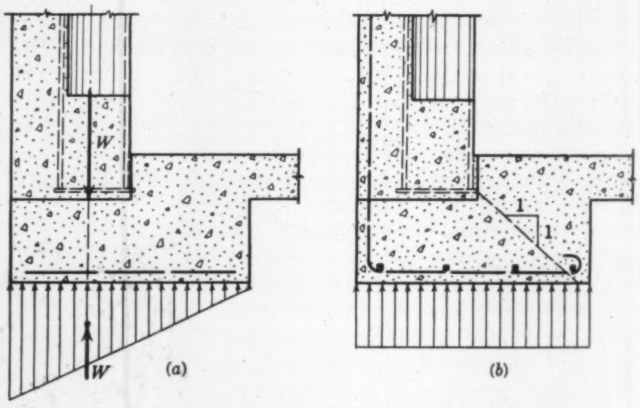


FIG. 2. ASSUMPTIONS FOR THE DISTRIBUTION OF PRESSURE UNDER WALL FOOTINGS

Since the total pressure acting upward on the structure must equal the total downward load, the hydrostatic pressure at the center reduces the pressure on the soil in the vicinity of the columns. The footings are designed for conditions with and without hydrostatic pressure, since it may be possible that the ground water will recede at some future time. As shown at B and D, Fig. 4 (), the inner edges of the footings are inclined. It has been found impracticable to maintain vertical faces where the soil is wet. The critical points for maximum bending moments are therefore A and E at the columns, C at the center of the "suspended span," and B and D at the junction of the slab with the footing. The required reinforcement is computed for these locations. Where the center columns are spaced 11 or $16^1/_2$ ft on centers, which is the case at the stations, the hydrostatic pressure must be transferred by continuous beams extending longitudinally in the line of the center columns, and the column loads distributed by means of isolated footings.

DESIGN OF CROSSOVER SECTION

A typical section of a subway invert below ground-water level and at a crossover, where the center column is omitted, is given in Fig. 5. Since the drainage system is similar to that for the center-column section, it has been omitted for clarity in the drawing. These crossovers occur at rather infrequent intervals.

For a 24-ft cover a wall footing about 5.7 ft wide is required. The limiting width of a cantilever footing, at an allowable soil pressure of 4 tons per sq ft, that would produce excessive compression in the concrete at the walls is about 4 ft for sections of the subway above ground-water level, where the walls are 2 ft thick, and about 5 ft for sections below ground-water level, where the walls are $2^1/_2$ ft thick. For shallower depths of cover, therefore, the cantilever method may be used, as for the center-column section. Beyond these depths other means of distribution must be resorted to, such as the use of the invert slab to carry the bending moment, or extension of the footing outside the subway walls. The latter method requires additional excavation and fill and also complicates the work of construction. An additional consideration in favor of the first method is that the increased thickness of the slab produces a more water-tight structure.

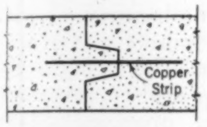

Copper Strip

FIG. 3. WATER SEAL AT CONSTRUCTION JOINTS

The inverts are computed as spans having partial fixity at the ends, the positive moment being reduced by the value of the moment which the wall is capable of sustaining. The load distribution and the shear and bending-moment diagrams for these load conditions are shown in Fig. 5.

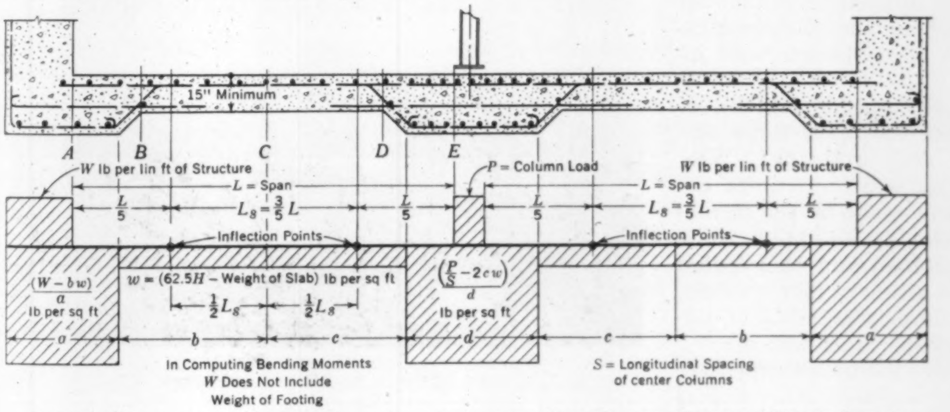

15" Minimum
A
B
C
D
E
W lb per lin ft of Structure
P = Column Load
W lb per lin ft of Structure
L = Span
L = Span
L/5
$L_s = \frac{3}{5}L$
L/5
L/5
$L_s = \frac{3}{5}L$
L/5
Inflection Points
Inflection Points
$\frac{(W - bw)}{a}$ lb per sq ft
w = (62.5H – Weight of Slab) lb per sq ft
$\frac{1}{2}L_s$
$\frac{1}{2}L_s$
$\frac{\left(\frac{P}{S} - 2cw\right)}{d}$ lb per sq ft
a
b
c
d
c
b
a
In Computing Bending Moments W Does Not Include Weight of Footing
S = Longitudinal Spacing of center Columns

FIG. 4. DESIGN OF INVERT SLAB FOR LOCATIONS BELOW THE GROUND-WATER LEVEL

(a) Reinforcing Diagram; (b) Loading Diagram

Certain soil conditions have been encountered in which the permissible pressure was considerably below that of 4 tons per sq ft ordinarily allowed. In this case the pressure of the structure, as well as that of the train loading and the weight of the track construction, was distributed over the invert by a mat. Such cases, however, have been of infrequent occurrence.

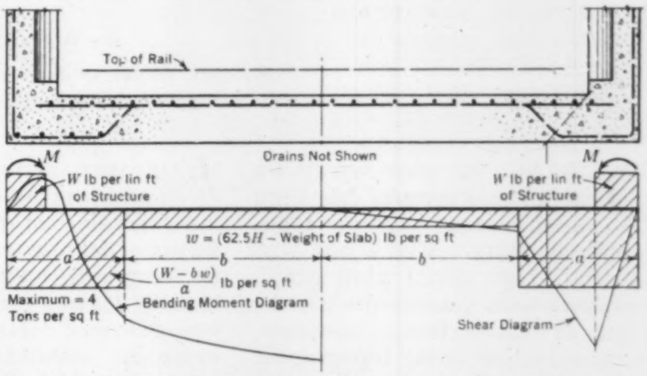

Top of Rail
Drains Not Shown
M
M
W' lb per lin ft of Structure
W' lb per lin ft of Structure
w = (62.5H – Weight of Slab) lb per sq ft
a
b
b
a
$\frac{(W' - bw)}{a}$ lb per sq ft
Maximum = 4 Tons per sq ft
Bending Moment Diagram
Shear Diagram

FIG. 5. TYPICAL INVERT FOR CROSSOVER SECTIONS WITHOUT CENTER COLUMNS

Diagram of Loads, Hydrostatic Pressure, Shears, Moments, and Reinforcement

When the Eighth Street undercrossing of the Market Street subway was excavated, it was found that the soil contained so much clay and mica that it was considered incapable of supporting both structures. The footings were then redesigned for pile foundations, the piles being steel tubes $^5/_{16}$ in. thick and 15 in. in diameter, filled with 1:2:3 concrete. These tubes were forced down to rock bearing by jacking against the existing Market Street subway foundations. It was computed that these piles carried a pressure of about 90 tons each. They were provided at the top with cast-iron caps encased in the concrete footings. Since hydrostatic pressure was encountered at this point, the invert was designed for it. The weight of the track structure and invert slab in the lower level was also considered as being transferred to the pile foundations. However, the unit stresses in the slab were increased 25 per cent on the assumption that the soil had some bearing value.

INVERT SLAB CARRIES BENDING STRESSES

The distribution of pressures on subway foundations does not usually involve assumptions other than those used in the design of ordinary foundations. However, for long spans, such as occur at crossovers and stations, and for heavy loads, it is sometimes necessary to distribute the pressure over part of the subway invert. It has been found economical in such cases to concentrate the pressures as close to the columns as the design will permit, and to make the invert slab carry the bending stresses. Hydrostatic pressure also produces a condition which materially increases the cost of the subway invert, in this case the thicker slab required for the bending stresses producing a more water-tight structure.

The design and construction of Philadelphia's subways are under the supervision of Charles H. Stevens, M. Am. Soc. C.E., Chief Engineer of the Department of City Transit.

Topographic Mapping by a Combination Method

Plane Table Supplements Aerial Photography with Gratifying Results

By W. N. Brown

Member American Society of Civil Engineers
W. N. Brown, Inc., Engineers, Washington, D.C.

For years aerial photography has constituted an important adjunct to topographic mapping, frequently with the aid of delicate stereoscopic apparatus for rectifying optical errors and accurately plotting contours. The method here described obviates the use of such expensive apparatus and is much simpler. After the aerial photograph has been corrected for scale and tilt by a simple device, most of the topographic features are transferred directly to a plane-table map showing horizontal control. It is then an easy matter to add the contours in the field, supply missing data, and correct errors. Such surveys are relatively cheap and at the same time amply accurate. This paper is sponsored by the Committee on Aerial Surveying and Mapping of the Society's Surveying and Mapping Division, of which committee S. D. Sarason, M. Am. Soc. C.E., is chairman and Mr. Brown is a member.

During the past few years aerial photography has been used extensively in topographic mapping. Every one who has studied an aerial photograph must have been impressed with the wealth of information it contains. The imagination of the topographic engineer immediately visualizes the great assistance an aerial photograph would be to him if these data could be brought to exact scale and position. He is further stimulated in this aim when he realizes that all these data, covering probably three square miles, were recorded within one hundredth of a second. A comparatively simple application of aerial photography to map-making is shown in Fig. 1. The development of methods for using aerial photographs was inevitable and has now progressed to a stage where it may be safely said that no standard survey of any magnitude will be undertaken without the aid of aerial photography.

Such development has been along two lines. In the first, the visible physical data shown on a vertical aerial photograph are extracted and plotted to a fixed scale and in correct position, producing a base map on which appear all the desired physical features, such as roads, railroads, streams, houses, fence lines, and other cultural features. The contours are located and placed on this map in the field. In the second method of development, stereoscopic principles have been utilized to obtain all the data, including the contours, from the photographs. Surveys made by this method are characterized as stereometric.

This article describes a non-stereometric method of surveying, using a combination of the plane table and aerial photography. One may very well ask: Why use the non-stereometric method, which involves extensive field work, if surveys can be made by the stereometric method directly from the photographs while enjoying the comforts of a well-lighted and well-heated office? Intriguing as may be this vision of map-making, the non-stereometric method offers some distinct advantages. Among those worthy of attention are:

1. Facility. It does not involve the use of expensive and patented equipment. Any engineer who understands aerial photographs and the laws governing the distortions that may occur in them, can use the method with success and economy.

2. Completeness. Certain physical features that should be shown on a map are not distinctly visible on even the best photographs, for example, houses and streams obscured by trees; straw stacks that look like houses; moisture lines in the soil that have the appearance of streams; and removed fences which, because of the location of shrubbery and cultivated areas, appear as possible fence lines. During the process of locating the contours instrumentally, the topographer checks the map for such misinterpretations and corrects them. Where accuracy is desired, such field checking is essential. Instrumentally determined elevations, correct to the nearest tenth of a foot, on bridges, railroads, road intersections, water levels, and critical topographic points, such as tops of hills and bottoms of depressions, are essential to the making of a complete map. These spot elevations are obtained by the topographic field parties as a part of the contour location. Also, the location of all monuments, bench marks, and other points marked on the ground is shown on the map and is valuable in transferring a proposed plan from the map to the ground.

3. Quality. Maps of large areas made by this method have been thoroughly tested and found to be unexcelled when compared with maps made by other methods.

4. Cost. The expense and time required compare favorably with these items in any other method.

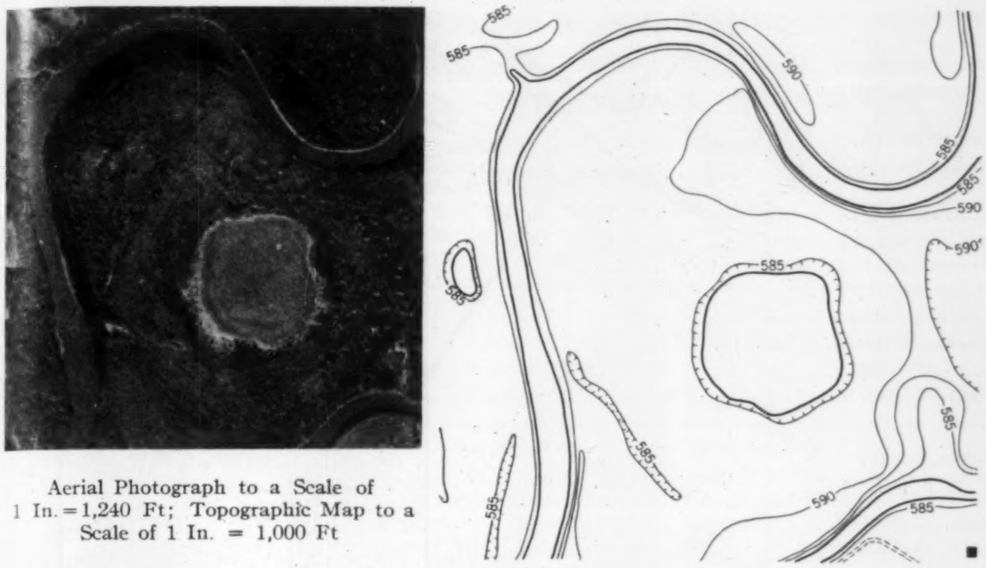
OPERATIONS CONSIDERED IN SEQUENCE

There are many variations of detail in the way this combination of plane table and aerial photography has been used, but the important steps in the recommended procedure can be briefly stated, as follows:

Typical Country Mapped by Means of Aerial Photography and the Plane Table
Mississippi River, near Red Wing, Minn.

1. A system of horizontal and vertical control is established, so designed as to meet the requirements of the selected map scale.

2. A set of overlapping vertical aerial photographs of the area is procured.
3. Definite points observable on the photographs are identified on the ground, and the position of a sufficient number of them is determined to enable the establishment of the scale of the photographs.



Aerial Photograph to a Scale of 1 In. = 1,240 Ft; Topographic Map to a Scale of 1 In. = 1,000 Ft

FIG. 1. ILLUSTRATING THE VALUE OF AERIAL PHOTOGRAPHS IN TOPOGRAPHIC MAPPING

4. All control and located points in the photographs are plotted on the plane-table sheets.
5. The aerial photographs are brought to the required map scale.
6. The corrected photographic data are transferred to the plane-table sheets in proper horizontal position with reference to the plotted control, thus providing a correct base map.
7. Contours are located instrumentally in the field on this base map, in proper relation to the control and the transferred photographic data, at the same time that the omitted or misinterpreted data are supplied and the desired spot elevations are added.
8. The final map is drawn and reproduced.

Before these various steps are discussed in detail, some general principles which must be followed to obtain the best results in any survey should be considered: (1) If a survey is worth making, it is worth the expenditure of time and thought in its planning. A definite and complete plan should be formulated before any money is spent on field work. (2) Although there are certain principles that apply to all surveys, each particular survey is a distinct problem. No fixed plan or procedure will apply exactly to two or more surveys. (3) There is an intimate relationship between map scale and map accuracy. First a decision must be made as to the degree of accuracy desired, and then the proper scale must be selected to permit such accuracy. Definite specifications stating the limits of error allowable in each of the component operations should be written and issued to the field men responsible for these operations.

Use of sound judgment in these matters will ensure a map of consistent accuracy at a minimum expenditure. I have seen surveys executed by engineers for large corporations, in which proper planning and correlation of the component parts would have cut the cost in half. Today engineers are being called upon to make surveys costing as high as $200,000.

The object of control is to prevent the accumulation of errors in a survey and also to provide a means for making location surveys from time to time of parts of a construction program, with the assurance that such parts, though widely separated, will be in proper relationship to the whole. The purpose of the survey, the size of the area to be surveyed, the nature of the country, and the scale of the map are all factors in determining the accuracy and character of the control required. Except where mapping is the only aim, the control must be designed to meet the needs of subsequent location and construction surveys.

Where the control is purely for mapping purposes, the selection of the map scale fixes the limit to which errors may be permitted to accumulate, that is, the minimum length that can be plotted on the map. Assuming that 0.01 in. is the practical minimum scale division which the eye can distinguish and that the selected map scale is 1 in. to 1,000 ft; then 10 ft, the smallest distance that can be plotted, is the limit of permissible accumulation of error. Knowing the size of the area to be mapped, one can determine the degree of accuracy with which the horizontal control must be run to avoid a total accumulation of error in excess of 10 ft.

If the area to be mapped is such that 20 miles of principal control traverse will be required to make a closed circuit, this traverse should be run with a closure error of less than 1 part in 10,000 before adjustment. It will usually be found advantageous to run two different classes of control. The second class may have a much lower order of accuracy than the first. Permanent monuments should be set at intervals along the lines of primary control, and adjusted values for the position of these monuments should be determined.

In finding the permissible error allowable for the secondary control, a study of the approximate location of the principal control should be made. This will show the probable length of secondary circuits between primary control monuments necessary to control the scale of the aerial photographs. Suppose this inspection indicates that such secondary control can be kept within a length of two miles. Then the permissible error of closure, before adjustment of the circuits, would be 1 in 1,000, an accuracy easily attainable with stadia.

Whether the control system is accomplished by triangulation supplemented by plane table (graphic triangulation), chained traverse, or transit stadia traverse; or whether any of these methods is used alone without triangulation, are problems that must be determined by existing conditions. Complete information as to how to attain the desired accuracy can be secured from the U.S. Government publications describing control-survey methods.

Where possible, the horizontal control system should be based upon or tied into the triangulation points of the U. S. Coast and Geodetic Survey in the area mapped.

Selection of the quantity and accuracy of the vertical control must be governed by the same principles. As in the horizontal, so in the vertical control, two classes, one primary and the other secondary, can often be used to advantage. The primary control is used to establish the elevation of permanent monuments and bench marks; the secondary, to supplement the primary in locating contours.

Wherever possible, the datum of reference should be mean sea level, based on the nearest U. S. Government bench mark. Ties should be made to the Government system as often as possible. The Government files contain a great mass of data of value in this connection to every engineer. Such data may be obtained by a simple written request.

SUGGESTIONS ON AERIAL PHOTOGRAPHY

Aerial photographs for this work should be taken with a single-lens camera. They must be approximately vertical; in no case should the tilt exceed 2 deg. They must be distinct, and they should be taken at a scale somewhere near the map scale, preferably about one-fifth smaller. If the map is to be on the scale of 1 in. to 1,000 ft, then the photographic scale should be approximately 1 in. to 1,200 ft. The focal length of the camera should seldom be under 12 in.—the longer, the better. While taking the photographs, the airplane should be kept at a constant altitude and on an even keel. Photographs should have a minimum overlap of 50 per cent in the line of flight. The overlap between lines of flight should be not less than 30 per cent. Marks should appear on the photographic negatives showing the center of each photograph. Success and ease in using the photographs depend upon the rigid maintenance of these conditions. To do so necessitates a good camera, good weather, and a steady plane, as well as a good pilot and an expert photographer, both of whom are experienced in map work. To expect good results under other conditions is futile.

Such photographs may be procured by employing commercial aerial photographers who specialize in such work, or by training one's own men and renting the airplane. If a commercial photographer is employed, specifications must be drawn up covering the requirements of the survey, and it should be stipulated that the negatives are to be the property of the mapmaker.

The principal variations in the scale of aerial photographs are due to variation in the elevation of the airplane, the tilt of the camera from the vertical at the time the photograph is taken, and variation in the elevation of the ground surface photographed. The first cause produces photographs having different scales, and the second and third causes produce a variation of scale in different parts of the same photograph. The changes of scale due to tilt can be eliminated without great difficulty. Those errors due to differences in elevation of the ground surface are harder to correct unless stereometric methods are used.

Rectification of the photograph is accomplished by projecting the image from the negative on a tilt board which can be moved in all directions. The plane-table sheet, with the plotted position of the picture points, is placed on this tilt board. By enlarging or decreasing the size of the projected image, and at the same time tilting the board to represent the amount of inclination of the camera at the moment the photograph was taken, the image of each control picture point is brought into exact coincidence with the plotted point on the sheet. When the photographic image is thus brought to scale, it is fixed photographically on sensitized film, resulting in a positive to proper scale. After the data have been transferred to scale, the plane-table sheets are ready for the topographer's use.

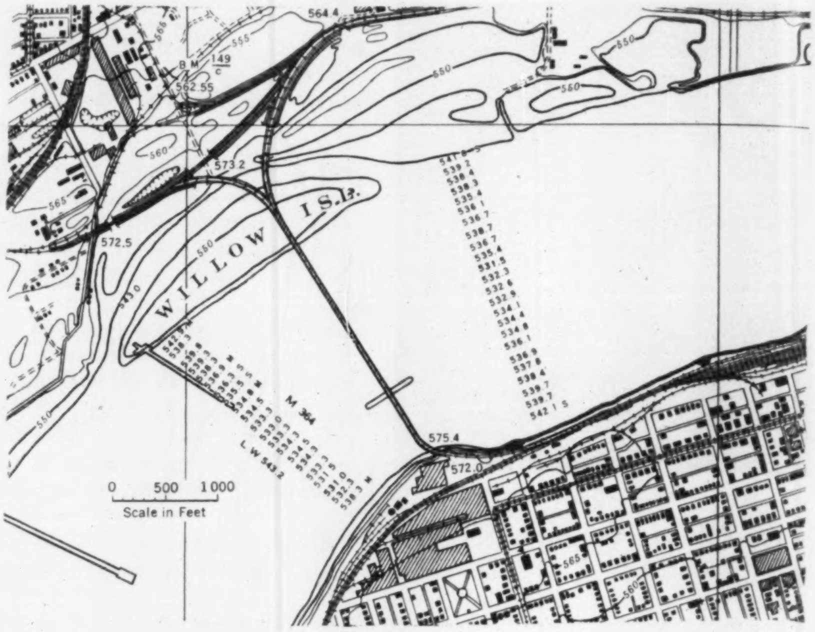


Fig. 2. Section of a Topographic Map of an Area near Rock Island, Ill.

When the plane-table sheets are sent to the field, they show such data as roads, railroads, streams, houses, fence and timber lines, control points, and bench marks in correct position. Starting from a control point of known elevation and position, the topographer runs the usual plane-table traverse, locating and sketching contours and checking for any omissions or misinterpretations of the transferred data. In the course of this work he determines and places on the map the desired additional spot elevations. In most areas he will find a sufficient number of definitely identifiable points plotted from the photographs to enable ready determination of his horizontal position, so that he only needs to carry a continuous line of levels with his plane table and alidade, using vertical angles where convenient. After sketching the contours, he returns the sheets to the office for the necessary drafting.

Surveying as here described gives better results when the terrain has only slight relief, because the local displacements within a photograph due to differences of elevation are then too small to introduce appreciable error. Where the terrain is very precipitous and the map scale is large, these displacements become objectionable and the method must be modified. Such modification is for the purpose of correcting the photographic data and is accomplished either by radial triangulation or by the use of additional ground control points situated at different elevations, to which the respective parts of the photographs are related.

In 1929 and 1930, a topographic survey of 1,603 sq miles of the Mississippi River valley was made by this method. Of this area, 963 sq miles required 5-ft contours and 640 sq miles were without contours but required all other topographic data, including spot elevations at road crossings, along railroads, and on bridges and tops of levees. The plotting scale was 1 in. to 1,000 ft. The specifications stated:

> All features shown on the maps shall be located with such accuracy that no error is measurable on the scale of the map. Elevations of artificial features affecting stream flow shall be accurate within one-half foot in elevation. Contours shall be shown with an interval of five feet and shall be of such accuracy that when careful profile lines are run in the field by the contracting officer between definite points located on the map and identified on the ground, at least 90 per centum of the test points determined by the profile lines shall not be in error on the map more than one-half the contour interval.

In character, the country ranged from intensely developed areas like Rock Island, Ill. (Fig. 2), to sections containing only swamps, sloughs, and timber. The extreme range in elevation on any one map sheet was 420 ft, but in a great part of the area the differences of elevation did not exceed 30 ft. The contract price for the work was $153.35 per sq mile for the contoured area and $80.00 per sq mile for the uncontoured area. This covered preparation of the completed map up to the point of reproduction. The time limit of 390 days included 120 days of winter weather.

This method was also used in mapping approximately 800 sq miles in Indiana along the Wabash and White rivers, to a scale of 1 in. to 833 ft, with a 10-ft contour interval. Under the same specifications for map accuracy, the contract price was $135.00 per sq mile and the time was 300 days.

APPLYING TESTS FOR ACCURACY

Tests for accuracy should be applied to determine whether the map meets the requirements of the specifications. These tests should be the same regardless of what mapping method is followed. Every map should be tested, whether made under contract or by engineers on a salary. If these tests are made while the map work is in progress, a study of the results will suggest possible advantageous changes in method. Such tests cost relatively little, and their universal adoption would encourage improved standards in survey work.

In 1912 the Department of Sewage of the City of Cincinnati made a topographic survey of the city. It required that 90 per cent of the points tested should be correct for horizontal position within the minimum map scale division (one-eightieth of an inch) and that contours should be correct within one-half the contour interval of 5 ft. In other words, the engineer in charge required a map in which scale distances are correct within 5 ft and scaled elevations within $2^1/_2$ ft, but he would tolerate errors greater than this amount to the extent of 10 per cent.

In testing, profiles originating at and closing on the control points were run across the map sheets for comparison with profiles scaled from the map sheets. This procedure has been followed in recent map tests, regardless of whether the map was made by aerial photographic methods or purely ground methods.

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Plotting Charts for Columns in Compression with Tension Over Part of Section

By ODD ALBERT, ASSOC. M. AM. SOC. C.E.
EAST ORANGE, N.J.

HOW is a design chart involving a number of variables constructed? This question is often asked of me. The answer is: By reducing the number of variables algebraically and expressing them in a single simple equation which can be plotted graphically within the four quadrants of a chart. I can best explain by an example of concrete design that is ordinarily considered somewhat complicated.

A column subjected to compression and bending, with resultant tension over part of its section, can be designed in two ways. The outside dimensions and the reinforcement being tentatively assumed, in order to find the stresses the neutral axis must be located. This is rather difficult as the equation obtained is of the third degree. Another method is to assume trial outside dimensions. The limiting stresses being known, the position of the neutral axis is fixed and the required reinforcement is easily found. In either case, if the result is unsatisfactory, reasonable adjustments are made and the analysis is repeated. In plotting the chart here described the second method has been used.

By definition, the "kern" is that central area of the cross section of a column on which a load can be applied without causing tensile stresses in the section; it corresponds to the middle third for a homogeneous section that is rectangular. Conversely, if an eccentric load, N (Fig. 1), is applied outside the kern, tensile stresses will exist in part of the section. These tensile stresses are assumed to be taken by the steel alone.

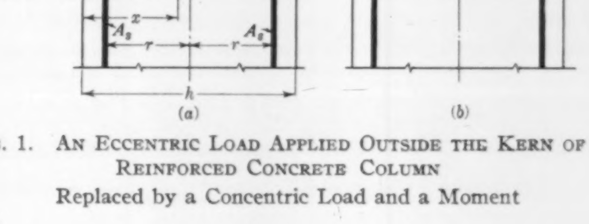


FIG. 1. AN ECCENTRIC LOAD APPLIED OUTSIDE THE KERN OF A REINFORCED CONCRETE COLUMN
Replaced by a Concentric Load and a Moment

The eccentric load, N, may be replaced, (Fig. 1b) by a concentric load, N, and a moment, $M = Ne$, in which e is the eccentricity.

Using standard notation, the following evident relations between the internal and external forces may be found:

$$N = {}^1/_2 f_c bx - A_s(f_s - f_s') \quad . \; . \; . \; . \; . \; . \; . \; . \quad [1]$$

$$M = {}^1/_2 f_c bx\left(\frac{h}{2} - \frac{x}{3}\right) + A_s r(f_s + f_s') \quad . \; . \; . \quad [2]$$

$$\frac{nf_c}{f_s} = \frac{x}{\frac{h}{2} + r - x} . \quad [3]; \quad \frac{nf_c}{f_s'} = \frac{x}{x - \frac{h}{2} + r} . \quad . \quad [4]$$

$$f_s - f_s' = \frac{nf_c}{x}(h - 2x) . \quad . [5]; \; f_s + f_s' = \frac{nf_c}{x} 2r . \quad [6]$$

$$N = {}^1/_2 f_c bx - A_s \frac{nf_c}{x}(h - 2x) \quad . \; . \; . \; . \; . \; . \quad [7]$$

$$M = {}^1/_2 f_c bx\left(\frac{h}{2} - \frac{x}{3}\right) + \frac{2nf_c A_s r^2}{x} \quad . \; . \; . \; . \quad [8]$$

From Equation 7,

$$A_s = \frac{({}^1/_2 f_c bx - N)x}{nf_c(h - 2x)} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad [9]$$

Combining Equations 7 and 8 and eliminating A_s from Equation 9,

$$M = {}^1/_2 f_c bx\left(\frac{h}{2} - \frac{x}{3}\right) + \frac{2r^2({}^1/_2 f_c bx - N)}{h - 2x} \quad . \quad [10]$$

Assume that $d' = 0.1h$. Then $d = 0.9h$; $r = 0.4h$; and $x = 0.9kh$. Transforming Equation 10,

$$\frac{M}{bh^2} + \frac{N}{bh}\,\frac{0.32}{1 - 1.8k} =$$

$$f_c k\, 0.45\left(0.5 - 0.3k + \frac{0.32}{1 - 1.8k}\right) \quad . \; . \; . \quad [11]$$

and from Equation 9,

$$A_s = pbh = \frac{(f_c bh\, 0.45k - N)0.9k}{nf_c(1 - 1.8k)} \quad . \; . \; . \; . \; . \quad [12]$$

But Formula 3 gives

$$f_s = \frac{nf_c(1 - k)}{k} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; . \quad [13]$$

and therefore, from Equations 12 and 13,

$$\frac{1 - 1.8k}{0.9(1 - k)} f_s p + \frac{N}{bh} = f_c\, 0.45k \quad . \; . \; . \; . \; . \; . \quad [14]$$

It is obvious that for different stresses of concrete the value of n will vary. For a concrete stress of 1,200, $n = 10$; for a concrete stress of 1,000, $n = 12$; and for a concrete stress of 800, a value for n of 15 is mostly used. Hence it can be assumed that $nf_c = 12{,}000$.

If Equations 11 and 14 are divided by f_c and a value of $\frac{12{,}000}{n}$ for f_c is used, then

$$\frac{M}{f_c bh^2} + \frac{N}{f_c bh}\,\frac{0.32}{1 - 1.8k} =$$

$$0.45k\left(0.5 - 0.3k + \frac{0.32}{1 - 1.8k}\right) \quad . \; . \; . \quad [15]$$

$$\frac{1 - 1.8k}{0.9(1 - k)}\,\frac{f_s}{f_c} p + \frac{N}{f_c bh} = 0.45k \quad . \; . \; . \; . \; . \; . \quad [16]$$

By eliminating $\frac{N}{f_c bh}$ in Equations 15 and 16,

$$\frac{M}{f_c bh^2} = \frac{f_s}{33{,}750(1 - k)} pn + 0.45k(0.5 - 0.3k) \quad . \quad [17]$$

PLOTTING THE CHART

Since k is a constant for known values of working stress, Equation 17 is in the proper form for a graphical solution, as shown in Fig. 2. In order, the variables are $\frac{M}{bh^2}$, f_c, f_s, and p. Note that if $\frac{M}{bh^2}$ is laid off on the axis OA, and if values of f_c are given by straight lines in the third quadrant, the axis OB will represent values of $\frac{M}{f_c bh^2}$ to a linear scale of division. Continuing to combine in a clockwise manner, values of f_s are introduced in the second, and values of n in the first, quadrant, giving in sequence values of pn on the axis OC and of p, per cent of steel, as the final result on axis OD.

It will be noted that Equation 17 for known stresses represents straight lines, one line for each stress. Thus, for instance, for $f_s = 18{,}000$, when $k = 0.40$, we get $\frac{M}{f_c bh^2} = 0.8889pn + 0.0684$. Let $pn = 0$; then $\frac{M}{f_c bh^2} = 0.0684$. If $pn = 0.3$, we get $\frac{M}{f_c bh^2} = 0.335$. These points connected with a straight line give the relation

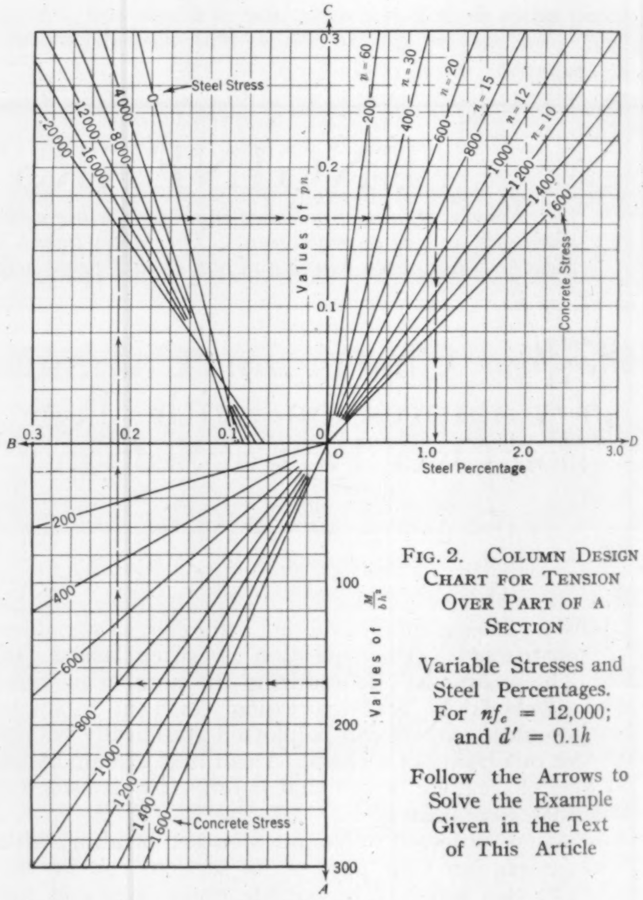


FIG. 2. COLUMN DESIGN CHART FOR TENSION OVER PART OF A SECTION

Variable Stresses and Steel Percentages. For $nf_c = 12{,}000$; and $d' = 0.1h$

Follow the Arrows to Solve the Example Given in the Text of This Article between different values for $\frac{M}{f_c bh^2}$ and pn to cause a steel stress of 18,000 lb per sq in. For other stresses the same procedure as has been here outlined is repeated.

It is known further that $nf_c = 12{,}000$, and therefore the product pn may be written $pn = \frac{12{,}000}{f_c} p$. From this relation the corresponding straight line in the first quadrant is determined. Note that the line representing $f_c = 12{,}000$ actually represents a value of $n = 10$.

As an example, a column 12 by 20 in. takes an eccentric load of 51,000 lb on its longer axis, so that $e = 16$ in. Assume $f_c = 800$ lb per sq in. and $f_s = 18{,}000$ lb per sq in. To find the percentage of steel, follow the dotted lines and arrows in Fig. 2, starting on OA with a value of $\frac{M}{bh^2} = \frac{51{,}000 \times 16}{12 \times 20 \times 20} = 170$. Then 1.1 per cent of steel will be required on both faces of the column. It will be noted that the chart can be used for any kind of stresses for both the steel and the concrete and also for different values of n.

Formulas for Using Dynamite in Canal Excavation

By N. J. HAINOVSKY, ASSOC. M. AM. SOC. C.E.

FORMERLY ASSISTANT ENGINEER, TELA RAILROAD COMPANY, TELA, HONDURAS

DURING work for the Tela Railroad Company in Honduras in 1929, I directed the excavation of more than 98,000 cu yd of drainage canal by the use of explosives in a swampy region, where other means of excavation could not be used, and had the opportunity to check the methods used and explained in published articles by others. The purpose of this article is to present a tentative formula which may be useful in systematizing the data of blasting with chambers, or with sprung loading holes, as applied to drainage canals of comparatively large cross section.

Although a determination of the amount of a dynamite charge is largely a matter of experience, I found my formulas of considerable practical value. They systematize working experience and eliminate many trial blasts, which are often necessary when soil conditions are changing.

The work for the Tela Railroad Company showed that the following conclusions could be drawn: (1) One pound of 50 per cent dynamite removes from 1 to $1\frac{7}{10}$ cu yd of dirt; and (2) the cross section produced by a blast of dynamite placed in the chambers at the center line of a proposed canal has a top width approximately equal to three times the depth, and a bottom width equal to the depth (see Fig. 1).

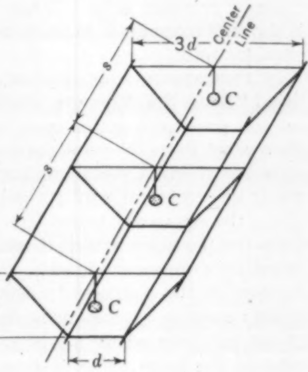


FIG. 1. ISOMETRIC DIAGRAM OF A CANAL EXCAVATED BY BLASTING

In the formulas presented, the following notation will be used:

C = charge of 50 per cent dynamite in one chamber, in pounds
d = proposed depth of the cut, in feet
V = volume of excavation to be done by one charge, in cubic yards
s = spacing between the chambers, in feet
r = explosive coefficient, or the amount of excavation in cubic yards for each pound of 50 per cent dynamite used. This coefficient varies from 1.0 to 1.7, depending on the soil and its water content
A = cross section of the cut, in square feet

The volume of excavation to be done by one charge is

$$V = \frac{As}{27} \quad . \ . \ . \ . \ . \ . \ . \quad [1]$$

The cross section, A, may be expressed in terms of depth by

$$A = \frac{3d + d}{2} d = 2d^2 \quad . \ . \ . \ . \quad [2]$$

Substituting this value of A in Equation 1, the result is

$$V = \frac{2\,sd^2}{27} \quad . \ . \ . \ . \ . \ . \quad [3]$$

To find the charge required, C, divide V by r, which gives

$$C = \frac{V}{r} = \frac{2\,sd^2}{27\,r} \quad . \ . \ . \ . \ . \quad [4]$$

The spacing between the chambers, s, is governed by the limit of blast propagation. If the charges are small and the spacing is large, a line cannot be fired in one shot. For chambers with loads of from 25 to 75 lb of 50 per cent dynamite, the spacing may vary from 5 to 7 ft. In dry, sandy soils or for light charges, 5-ft spacing is used. When the chambers are placed below the water table and heavy charges are used, 7-ft spacing is recommended.

The value of r is larger for heavy clay soils and smaller for sandy soils. In exceptional cases, in soft muddy swamps, the value of r may become less than 1.0, depending on the depth of the muck.

Assuming a 6-ft spacing and substituting numerical values in Equation 4, the results are as follows:

$$\text{For } s = 6,\ r = 1.0, \text{ and } C = 0.45\,d^2 \quad . \ . \ . \quad [5]$$
$$\text{For } s = 6,\ r = 1.35, \text{ and } C = 0.33\,d^2 \quad . \ . \quad [6]$$
$$\text{For } s = 6,\ r = 1.7, \text{ and } C = 0.26\,d^2 \quad . \ . \ . \quad [7]$$

Equation 6 leads to the following practical rule: For the first experimental blast, the number of pounds of 50 per cent dynamite in chambers spaced in one line, 6 ft apart, should be equal to one-third the square of the depth, in feet, to be cut.

If a systematic study were made of the coefficient r, special tables, which would be of considerable practical value, could be prepared for that coefficient as a function of the soil characteristics. The depth at which the charges are placed varies from 0.5 to 0.8 of the depth to be blasted, depending upon the type of soil. The proper depth could also be shown in the tables for the coefficient r.

The data used in deriving the formulas were all taken from my own experience with soils that varied from heavy clay to light sandy loam. The formulas are therefore applicable only to similar conditions.

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Irrigation and Roads in China

To the Editor: Please accept our sincere appreciation for the publication of the photographs of modern irrigation in China, which appear in the October number. It is a source of tremendous interest to the people of the United States that China is going in for irrigation projects and roads, the two main features of the program which abolished famine in the old sense from India.

It is difficult to make business and professional men realize that an organization founded on a basis of charity is showing the way to the most significant of the tremendous changes now under way in China. We have shown the Chinese how famine can be abolished, and they are taking hold in a surprisingly liberal manner.

The late Calvin Coolidge said that, with China's demands stepped up to equal those of Japan, the annual imports of the former country would be eight thousand million dollars. While we do not deviate from our purpose of charity, we are not blind to the fact that no other undertaking approximates what we have done and are doing in China in bringing about the status of which Mr. Coolidge spoke.

D. O. Lively
National Director, China Famine Relief, U.S.A.

New York, N.Y.
October 17, 1933

Data on Tainter Gate Openings Incomplete

To the Editor: In his discussion of my article, "Discharge Through Tainter Gate Openings," in the July issue, Mr. Gumensky presents a perfectly natural criticism of the method of computing the discharge by taking the head as that of the vertical distance from the upper water-surface level to the center of the gate opening. I am well aware of the fact that this is the head usually taken for flow through a free-discharge orifice. The following quotations from my article should be kept in mind.

> "From the meager data at hand, an effort has been made to compute discharges and compare them with the actual discharge through a fully opened gate. . . . As the full gate opening is approached, the results of the computations become more extravagant when compared with values determined by the orifice discharge formula. . . . In attempting to reconcile the flow through a gate with the experimental data for flat crested weirs it must be remembered that the experiments on which the formula is based were made under heads much less than those at the Fulton Dam."

From these few quotations it is readily seen that I have been unable to justify any existing formula on the basis of the meager data secured. To date searches for data covering the use and efficiency of Tainter gates have been fruitless. My article was an attempt to initiate the production of literature on the subject. No effort was made in it to establish any equations, but rather the aim was to show what might be the relation of such gate efficiencies to equations already existing. Moreover, no dogmatic statements were made excepting those founded on the facts of the experiments as outlined.

An attempt to determine discharges through Tainter gate openings leads to very much the same situation in regard to established equations of discharge as does an attempt to determine the flow from a given drainage area by an arbitrary equation. Standard works in my library and also in the public library of the City of Buffalo, which includes a large technical branch, show that the run-off from a certain area could be 2,376 cu ft per sec or 7,289 cu ft per sec. These are the extremes of five different equations from five different authors and prove that the experience and judgment of the person making a computation for design are of greater importance than the equation itself.

I realize that the measurements taken over twenty years ago were crude. However, they were the best that could be obtained under the circumstances and should be considered only as a preliminary step toward securing more accurate measurements and data. Such results can be secured only by the exchange of information among engineers.

Theron M. Ripley, M. Am. Soc. C.E.
Consulting Engineer

Buffalo, N.Y.
November 3, 1933

Vacuum in Soil Mechanics

To the Editor: In the hope of eliciting the opinions of others, I would like to expound here a theory relating to soil mechanics. This theory is that when the particles of a soil tend to, or do, move apart, a vacuum holds them in position and resists movement. The situation is analogous to that of two plane surfaces pressed together, in which case the atmospheric pressure would resist an effort to pull them apart. If upheld, the theory would explain many phenomena of soil pressure and behavior.

In a mass of granular material, such as sand or gravel, the particles are in intimate contact and at rest. When the material is in a dry state, the voids are filled with air. Suppose that some particles tend to move, or actually do move, as on a plane of rupture. This would cause, or tend to cause, an increase in the void volume next to a particle trying to move away from its neighbors. Air would enter instantly and fill any enlarged space, and the forces acting would be gravity and friction between the particles.

Again, suppose that the voids are full of water, that is, that the soil is saturated but not supersaturated. Then, if a particle moves, or tries to move, away from its neighbors, the water, not being elastic, would not expand in the void like a gas, and a partial vacuum would tend to form. In this case the atmospheric pressure acting against the particles of the mass would hold the particle trying to move and prevent an enlargement of the void. As the particle and void under consideration are not at the surface, it would require considerable time for the atmospheric pressure to force the water through the interstices of the mass to fill the vacuum, since these interstices are small and the passages intricate. Such flow of water would be resisted by its surface tension and its friction along the surfaces of the particles. Therefore, in addition to gravity and friction in the dry mass, there is a new force at work, a component of the atmospheric pressure, which resists any movement of the mass to create a vacuum. What has been called "cohesion" in a granular mass is primarily this resistance to the creation of a vacuum.

In clay the particles are smaller and of less defined shape than those of granular soils. When clay contains water, the tendency of slipping to create a vacuum would be similar to that in saturated granular soils.

In Proceedings for November 1933, I contributed a paper entitled "Some Soil Pressure Tests," which showed that the horizontal soil pressures under conditions of saturation were much less than those from the same mass when dry; and they were even less after a correction was made for the reduced weight of the mass in water as compared with its weight in air. The tests also showed that "the retreating water (from drainage) removed some support from the particles, which it maintained while the mass was saturated in a quiescent state. On the next irrigation the apparent support of the particles by the water was restored." These test results may be explained by the tendency to cause a vacuum between particles whose voids are filled with water. It also would explain the large value of ϕ, as shown by the tests; that is, a ϕ taken to represent an angle of internal resistance rather than one of repose, as ordinarily defined in formulas for earth pressures.

This vacuum theory seems to be the logical explanation for the reduced horizontal pressures that the tests showed, since the water otherwise would act as a lubricating rather than as a resisting element. Furthermore, the vacuum theory would explain some of the results which occur when a load is placed on a bed of soil that contains water in a nearly or fully saturated condition.

H. DE B. PARSONS, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
November 4, 1933

Control of Industrial Wastes in Michigan

TO THE EDITOR: The article by Mr. Warrick, in the September number, is founded on an active knowledge of the problem of pollution from industrial wastes. Wisconsin's progress, particularly in the solution of problems of cannery, paper-mill, and milk waste, is held in the highest regard. The work done in Pennsylvania is also outstanding, particularly in the field of treatment of tannery wastes.

In Michigan problems connected with the disposal of industrial wastes are largely concentrated in the southeast and south-central parts of the state, although there is an increasing problem of pollution from oil and brine wastes in the north-central part as a result of the development of oil fields.

Problems of industrial waste in Michigan may be grouped as follows: 73 canneries, 278 milk products plants, 16 beet sugar plants, 44 paper mills, 16 tanneries, 57 gas plants, and 18 gravel washing plants. In addition, there are 55 miscellaneous industries, including woolen and knitting mills, wood distillation or charcoal and wood-alcohol plants, chemical plants in connection with the development of salt and brines, and three oil refineries.

A relatively small percentage of these industries are creating critical or unlawful conditions in Michigan waters. The fact that all units in any group are not guilty of an equal degree of violation in some cases has been an obstacle to more effective group cooperation. Committees on pollution from industrial wastes, in cooperation with the commission for the control of the polluting material in these wastes, have been organized and are functioning for the paper mill, cannery, tannery, gas-house, and milk-products groups.

Some progress has been made, but much remains to be accomplished. We are convinced that cooperative effort between state and industry is the key to the solution of existing problems. The experience of the State of Michigan indicates that there are certain factors that tend to advance, and others that tend to retard, the success of such efforts. The considerations that must be kept in mind then are as follows:

1. The primary necessity and purpose of industry are to make a profit on its operations, even though it oversteps a reasonable use of its available water resources.
2. The purpose of the state, actuated by an ever-increasing public interest in the subject, is to correct the unreasonable use of its water resources.
3. Excessive regulation of stream flow by means of dams and their operation is a contributing factor in the upsetting of the oxygen balance in streams receiving controlled pollution.
4. Seasonal water temperature is a factor.
5. Seasonal flow variation is another factor that must be considered in establishing stream standards for industry.
6. The problem of cooperative effort is complicated by the necessity of requiring more treatment from one unit in a certain industrial group than from another in the same group located elsewhere. This is due to the lack of uniform water resources and to the variation in the oxygen-consuming value of wastes produced at one plant as compared with those produced at another. Where industrial treatment is required in excess of the degree resulting in a return of salvageable by-products, we are often faced with the problem of interstate and intrastate competition between like units of a single industrial group.
7. The subsequent use of water subject to pollution is a factor bearing on waste-treatment requirements and the success of cooperative effort.
8. Perhaps the most effective factor in securing cooperation is the underlying jurisdiction possessed by any state, through which compliance may be secured by state or riparian action when cooperative effort fails to obtain the desired results.

It is generally recognized that control of pollution rather than prohibition of it must be the rule for the future. The doctrine of "reasonable use" of our water resources, as enunciated by the courts of Michigan and other states, compels the adoption of such a policy.

MILTON P. ADAMS
Executive Secretary and Engineer
Michigan Stream Control Commission

Lansing Mich.
November 3, 1933

Data on Design of Details of "Skyway"

TO THE EDITOR: In connection with Mr. Grove's paper on the "Design of 'Skyway' and Observation Towers," published in the September issue, I would like to discuss the more important problems involved in the erection of the structure.

For the proper functioning of the "Skyride" and elevators, it was of primary importance that the towers be erected plumb. In this consideration two factors were involved: first, the behavior of the pile foundations under load, and second, the exactness of fabrication of the structural steel. The four main legs of each tower form a rectangle 50 by 110 ft in plan. At each corner the footing rests on 64 wooden piles, 65 ft long, driven through a miscellaneous-fill material to a penetration corresponding to a carrying capacity of 25 tons, in accordance with the *Engineering-News* formula.

It was essential that the four groups of piles be driven so that the settlement of the four points of support would be equal. After the four footings were driven, the resistance of each group as a unit was estimated on the basis of the individual pile resistance, and additional piles were driven where necessary to make the four units of support equal in strength. This method worked out satisfactorily since upon completion of the structure it was found that the average settlement of the footings was $^5/_8$ in., with a variation between maximum and minimum readings of only $^1/_8$ in.

The erection of the steel in the tower was accomplished by means of a steel guy derrick having a mast of 110 ft, a boom of 100 ft, and a capacity of 15 tons. This derrick was advanced two panels at a time, a vertical distance of 50 ft. The steel was so well fabricated that without benefit of field reaming the greatest departure of the top point of the tower (about 600 ft above the ground) from perfect plumb was 1 in.

Cable erection involved the placing of 308 separate rope members. Each was delivered to the site after being pre-stressed, cut to length, and socketed in the shop. All connections of the cable system to the main towers are by means of links, which permit free motion along the axis of the structure. These links are located at the top of the tower and at the Skyride level. During erection, the adjustable connections of the cable were at the anchorages, where 4-ft strand legs were provided to control the upper tower links, and a $3^1/_2$-ft forward displacement of each counterweight was made in order to slacken the rope system so as to permit of erection. The release of the counterweights controlled the positions of the links at the Skyride level of the towers. It is worth noting that the erection of this cable system included not only many features of conventional practice in cable erection but also required the balanced procedure used in the erection of suspended structures for suspension bridges.

Since the suspended system did not contain a structural stiffening member, it was not of prime importance that the cables be set at an elevation, as is the practice in suspension-bridge work. Dependence was placed entirely on the correctness of the rope lengths as cut in the shop. It was necessary, then, to make only slight relative adjustments of the ropes in any one group, so as to ensure equal distribution of stress within the group.

The anchorages proved efficient in resisting horizontal displacement. Under a horizontal component of cable pull amounting to

710 tons, the west anchorage showed no movement at all while the east anchorage moved forward $^1/_2$ in.

R. Boblow, Assoc. M. Am. Soc. C.E.
Resident Engineer, Robinson and Steinman, Designing Engineers

New York, N.Y.
November 2, 1933

Illinois Waterways Terminus

To the Editor: The article by Colonel Sultan and Lieutenant Ogden, in the August issue, is very timely. It is not an accident that there is a great commercial and industrial center at the south end of Lake Michigan. This obstruction to land transportation, from 60 to 118 miles wide, covering 22,400 sq miles and extending southward from the Canadian boundary a distance of nearly 400 miles, made it necessary for the railways from the east and from the northwest to converge at the south end of it. Such a condition was bound to create a great railroad center at this point. When, in addition, there happened to be a waterway connecting the lake with the Atlantic seaboard, and also two rivers capable of serving as lake harbors, then the great railroad center was certain to become also a point of interchange between the Great Lakes and the railways.

I concur heartily with the view expressed by the authors that the lake traffic which remains on the Chicago River should be diverted as rapidly as possible to the Calumet River. Much has been done along that line. It happened that my first employment on river and harbor work was in this district 44 years ago under Capt. William L. Marshall, then District Engineer and later Chief of Engineers, U. S. Army. He inaugurated the improvement of the Calumet River and for so doing was denounced by the Chicago press as an enemy of the city who was seeking to divert commerce from Chicago, because at that time the Calumet River was not included within the limits of the city.

Since that time the commerce of the Chicago River has been reduced from 8,000,000 tons to less than 2,000,000 tons, and there has been developed along the Calumet River a wonderful industrial district, with a commerce in normal times of 15,000,000 tons per year. Objection to the development of the Calumet District has long since ceased, and today I know of no opposition to establishing a modern industrial and transfer harbor in Lake Calumet at the head of the 21-ft channel constructed by the Federal Government.

At the present time the only questions to be settled are: what shall the plan be, who shall build it, and how shall the money be raised. In 1925 the U. S. War Department issued a permit to the City of Chicago for the development of the harbor according to the Van Vlissingen Plan, and the City Council passed an ordinance authorizing the Nickel Plate Railroad Company to construct the first unit, in return for which it was to receive a certain amount of land along the harbor and authorization to operate the belt railroad around the harbor. There was much opposition to this program, and it was not carried out. The details of the controversy need not be rehearsed here.

The Van Vlissingen Plan has been modified south of 122d Street by the special board of Army engineers that has just reported on the matter of enlarging the Calumet-Sag Canal and widening the Little Calumet and Calumet rivers, between the head of the Sag Canal and the head of the 21-ft Federal project. It is not anticipated that the Federal Government will construct the entire harbor. If the work is authorized by Congress, the main channel will be dredged by the War Department, but the building of bulkheads, warehouses, street approaches, railroad belt line, and connections must be done by local interests. Now that the 9-ft Illinois Waterway to the Mississippi River is in operation, and better business conditions are returning, it is believed that this project will be given a new impetus and that within a few years the construction of Lake Calumet Harbor may be well under way.

John W. Woermann, M. Am. Soc. C.E.
Senior Civil Engineer, U. S. Engineer Office

Chicago, Ill.
October 31, 1933

The Problem of the Chicago River

To the Editor: Of timely interest is the article by Messrs. Sultan and Ogden, in the August issue. The topography of the City of Chicago, particularly along the banks of the Chicago River, has made it possible to bridge the stream at costs that were not prohibitive. The narrowness of the river made long spans unnecessary, so in the early days of the city a program of bridge construction was initiated. Today in the metropolitan center of the city, a bridge spans the river at the foot of every street, which means that the bridges are approximately 400 ft apart. Because of the narrowness of the river there has been no geographical separation of the region, as in the case of New York City and Brooklyn, or of Camden and Philadelphia. Had the river been wide, bridge construction would have been costly and the river crossings consequently few.

Engineers attempted to make these bridge structures, and particularly those built in later years, of artistic design, which resulted in the adoption of the curved lower chord. It is this feature that is particularly troublesome at the present time when attempts are being made to establish an underclearance. Obviously, the vertical clearance has a very definite limit. However, if it were not for the curved lower chords in the bridges over the Chicago River, it would be possible to carry the vertical clearance for a greater horizontal distance across the channel.

These conditions confront every engineer who attempts to analyze the situation for the purpose of establishing a future policy of bridge construction that will be compatible with an adequate waterway policy for our internal rivers. The fact that the population of Chicago is likely to increase very rapidly must be kept in mind. Such growth will of course increase the volume of street traffic and thus make more objectionable the interruption to the flow of this traffic occasioned by the periodic lifting of bridges to permit the passage of masted vessels. Under these circumstances, the "nuisance" resulting from movable bridges will continue to grow more acute, and it is inevitable that the Chicago River should ultimately be spanned by fixed bridges. The authors' suggestions on that subject may be accepted as logical. They believe that if possible a scheme should be worked out, which will permit of the uninterrupted passage of land traffic over the bridges and at the same time of the uninterrupted passage of canal barges up and down the river.

The kind of tows and towboats used on the Chicago River affects the problem of navigation. Consideration of the character of these craft should have a bearing on the location and design of river terminals. Breaking of bulk will probably be required at some point well outside the city limits, and it will be necessary to devise a system of cargo handling and towing that will suit the physical limitations of the local rivers.

In the study of bridges as related to waterway traffic and in the determination of a future policy in regard to port terminals, attention is now being diverted from the central zone of the city to the Calumet district. The decision of the Federal Government to improve Lake Calumet and to enlarge the navigable capacities of the rivers in the Calumet region, together with the Calumet-Sag Canal, is consistent with the industrial development of the region and the usefulness of the Chicago system of internal waterways. The unrestricted construction of additional terminals in the central zone should be discouraged unless it is definitely proved that existing facilities cannot be suitably modified or that they are entirely inadequate.

M. W. Oettershagen
Harbor Engineer, Bureau of Rivers and Harbors

Chicago, Ill.
November 1, 1933

Basic Data in Planning for Slum Clearance

To the Editor: In connection with Mr. Millar's article in the September issue, it may be of interest to describe some of the basic data available in Cleveland and to indicate how these aid in planning for slum clearance.

Cleveland and other cities having populations of 500,000 or more, according to the 1910 census, were laid out in small, geographically constant areas or census tracts. Since these areas are constant geographically, their population trends can be readily determined. The gross as well as the net density of each area is known, and the latter varies considerably between census tracts. Also, the characteristics of the population of each small area are known for 1910, 1920, and 1930. The detail for 1930, as shown in my book, *Population Characteristics by Census Tracts,* Cleveland, Ohio, 1930 (published by the Cleveland Plain Dealer), includes for each of the 252 census tracts in the Cleveland five-city area many of the data published for states and cities by the U. S. Census Bureau.

In one census tract it was shown that 65 per cent of the heads of families were born in Czechoslovakia and 12 per cent in Poland, and in another that 68 per cent were born in Italy. In one census tract 66 per cent of the heads of families were classed as native white of native parentage, and in another tract 95 per cent were Negroes. Populations move about within the city. Census tract M-7, which had a Negro population of 8.7 per cent in 1920, showed an increase to 90.6 per cent in 1930.

Likewise, the economic status varies with the census tract. In several tracts the equivalent monthly rental was under $15. Only 15.5 per cent of the families had radio sets; as many as 44.6 per 100 families were unemployed; only 25.7 per cent owned their own homes; and only 16.4 per cent lived in one-family dwellings.

In contrast to that there were other census tracts in which the equivalent monthly rental was over $100, and 87.4 per cent of the families had radio sets. Few of these—only 2.7 per 100 families—were unemployed; 75.9 per cent owned their own homes; and as many as 83.0 per cent lived in one-family dwellings.

The first report of the Real Property Inventory makes available more material by census tracts: (1) The number of dwellings is shown in 8 classifications and the family units in each classification by occupancy and the number of extra families. (2) The number of stores by 20 types and by occupancy is presented as well as the use of other buildings and of land, creation of lots, construction and foreclosure data.

Distribution of all sorts of data useful to the merchandizer of consumer goods is available, such as the percentage of the families in each census tract that have a telephone; and the number of automobiles per 100 families. (This ratio varies from 11 per 100 families to 174.)

Social data of all kinds are also available to show whether or not an area is a slum. For instance, in one area with a population of 100,000 there were 210 murders in an 8-year period; 164 houses of prostitution found in seven undercover surveys; 48 boys taken to Juvenile Court per 1,000 boys from 10 to 17 years of age; 88 babies dying per 1,000 births; 775 cases of tuberculosis on record April 1, 1930; and 658 deaths from tuberculosis during a 4-year period.

In another area of 100,000 population there were found to be but 1 murder; 1 house of prostitution; 6 boys taken to Juvenile Court per 1,000 boys from 10 to 17 years of age; 39 babies dying per 1,000 births; 56 cases of tuberculosis on record on April 1, 1930; and 92 deaths from tuberculosis.

Such basic data are of no value in themselves but when carefully studied provide a sound basis for judgment. The facts regarding real property for the entire district are of slight value until analyzed by specific small areas and by specific types of property.

Howard W. Green, M. Am. Soc. C.E.
Secretary, Cleveland Health Council

Cleveland, Ohio
November 5, 1933

Federal Housing Corporation Desirable

To the Editor: The article by Mr. Millar on "Preparedness for Slum Clearance," in the September issue, is very timely. I should like to present here the substance of the discussion of this article that I gave at the Annual Convention last June. There are two important possibilities to be considered in connection with the 30 per cent grant that the National Recovery Act permits the Public Works Administration to make to public housing authorities.

Where private limited-dividend corporations undertake housing projects without any grant of Federal funds they may suffer a serious disadvantage later when they are placed in competition for tenants with projects under public authority that have been able to write off 30 per cent of their cost by virtue of the grant. In fact, the very threat of such competition may be one factor among many which will prevent the successful initiation of limited-dividend operations by private enterprise. This kind of difficulty can be obviated, at least in part, if the public authority uses its grant to reduce rentals and competes in a somewhat different field from that which the limited-dividend corporation can reach by renting its houses only to families who cannot afford the higher rate necessary to liquidate the limited-dividend project.

In view of the obvious difficulties ahead in getting public housing authorities successfully and incorruptibly established by state legislative action, the possibility of a Federal housing corporation should not be overlooked. Such a corporation is entirely within the scope of the National Recover Act. In many ways only such an agency could surmount the difficulties surrounding both private limited-dividend operations and local public housing authorities, and make real progress toward the development of demonstration re-housing projects based on sound standards. The 30 per cent grant, which otherwise would go to local housing authorities, could be used by the Federal housing agency in writing off excessive land costs and in bringing the total rent structure down to the range within which it is most needed.

Jacob L. Crane, Jr., M. Am. Soc. C.E.
Planning Consultant

Washington, D.C.
October 26, 1933

Direct Taxes for Financing Public Works

To the Editor: The title of a symposium in the August issue of Civil Engineering asks, "Can the Costs of Government Be Reduced?" Any attempt to answer this question in the affirmative immediately involves the matter of fixed charges, the major item in most government budgets and one that cannot readily be reduced. In municipalities, counties, and the like, however, these charges might be reduced during years of depression at the expense of increased expenditures during prosperous years, by a strict requirement that a certain percentage, say 20 or 25 per cent, of the cost of all so-called permanent improvements be raised by direct taxation. All other requirements, such as limiting such expenditures to a fixed percentage of assessed valuations, would remain as at present. The accompanying chart, Fig. 1, shows the effect of such a requirement on fixed charges.

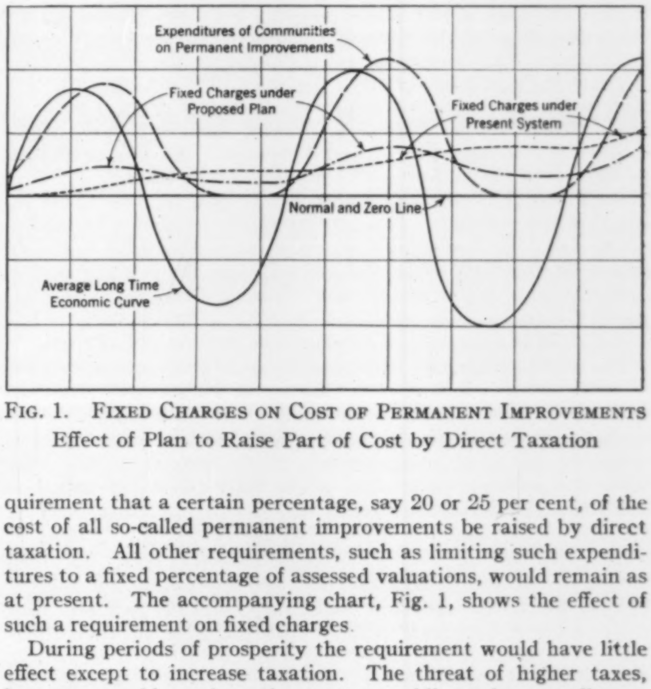


Fig. 1. Fixed Charges on Cost of Permanent Improvements
Effect of Plan to Raise Part of Cost by Direct Taxation

During periods of prosperity the requirement would have little effect except to increase taxation. The threat of higher taxes, however, would not be a deterrent to public works expenditures. Although rents are high at such times, buildings are fully occupied.

Markets are demanding the products of the farms, but poor roads prevent quick deliveries. Numerous other similar conditions cause a demand for public improvements. The public does not mind paying high taxes while money is plentiful. If such a program of direct taxation did have the effect of reducing public works expenditures during prosperous years, it would help, since the smaller issue of bonds would still further decrease the fixed charges. Incidentally, it would reduce competition with industrial improvement expenditures at a time when they are large. During periods of depression the community would reap the benefits of the plan in the form of decreased fixed charges and decreased taxes.

It may be argued that such a requirement for direct taxation would smother any attempt to spend money for permanent improvements during depression years, when public works are greatly desired as a buffer against a complete cessation of expenditures for industrial improvement. True enough, but in the recent depression, except in the case of the states and the Federal Government, expenditures for public improvements almost ceased anyway. Actually the requirement might have the opposite effect. The reason for the complete cessation of public works expenditures by municipalities was the large tax burden of which fixed charges are a major part. With a reduction in the latter, the public demand for a reduction in taxes would not be so great, and those in control might even be courageous enough to institute some public works projects.

JOSEPH BARNETT, Assoc. M. Am. Soc. C.E.
Chief Draftsman, Westchester County Park Commission

White Plains, N.Y.
October 30, 1933

Pittsburgh and the City Plan

TO THE EDITOR: The article by Mr. Young on "The Value of Planned City Development," in the September number, presents the ideal toward which all engineers intimately connected with planning activities are working. The accomplishment of the Chicago Plan Commission in bringing about the construction of sixty of the major public improvements recommended by the commission shows conclusively the value of such careful plans. Furthermore, the value of the improvements to the abutting properties is evidenced by the fact that property values, plus the consequential building development, were of sufficient magnitude to return to the city in increased taxes a yearly increment equal to one-half the cost of the city's share in the project.

The initial attempt to develop a technical city plan in Pittsburgh was made in 1910 by Frederick Law Olmsted, who prepared a survey and report on *Pittsburgh's Main Thoroughfares and the Downtown District.* This work was done under the direction of the Pittsburgh Civic Commission. In the same year a companion study and report on *Pittsburgh's Transportation Problem* was made by Bion J. Arnold, for the mayor and the council of the city. Later a work entitled, *Economic Survey of Pittsburgh,* was prepared and published by Dr. J. T. Holdsworth. These studies and reports acted as a stimulus to planning activities.

In 1911 the Pennsylvania State Legislature authorized the creation of an additional department for the government of cities of the second class, to be known as the Department of City Planning. In 1919 the work of this official planning body was augmented by the organization of the Citizens Committee on the City Plan of Pittsburgh. This committee was organized for the single purpose of producing a plan for the city. Between 1920 and 1923 it issued reports on the following subjects: *Pittsburgh Playgrounds, A Major Street Plan for Pittsburgh, Transit, Pittsburgh Parks, Railroads of the Pittsburgh District,* and *Waterways.* All of these created an interest in better and more comprehensive planning.

Metropolitan Pittsburgh embraces an area of over 1,500 sq miles, with a population of nearly 2,000,000—a density of 1,271.7 per sq mile. In developing a system of major and radial highways and of metropolitan parks, the Pennsylvania State Highway Department, the Commissioners and Planning Commission of Allegheny County, and the officials of the City of Pittsburgh have endeavored to coordinate and develop their plans as a single unit.

The past 12 years have witnessed the era of greatest construction of public works projects in the history of Pittsburgh. The city and county have spent over one hundred and fifty million dollars on major improvements, the majority of which are within the city.

Among the outstanding features of the Pittsburgh Plan that have already been undertaken is the Inter-District Traffic Circuit, which provides a complete by-pass around the central business district. It is estimated that the circuit, which is 6.72 miles in length, will cost approximately thirty million dollars. Included in this project are the Liberty Tubes and approaches, the Liberty Bridge, the North Side–West End Bridge, and the Saw Mill Run Boulevard. A completed major improvement is the Ohio River Boulevard, which is 5.5 miles in length, and forms a major link in the county highway system. The cost of this project and of the McKees Rocks Bridge was approximately $11,548,000. Another project that has been completed is the Allegheny River Boulevard, a 4-mile link connecting the easterly City Line with Verona Borough. This was built at a cost of $3,150,000.

Outstanding humanitarian developments include Frick Park, which embraces an area of 375 acres. This was the gift of the late H. C. Frick, who set aside the sum of $2,000,000 to be used for the development and maintenance of the area. North Park, embracing an area of 2,199.77 acres, and South Park, containing 1,803.24 acres, are owned and maintained by Allegheny County.

U. N. ARTHUR, M. Am. Soc. C.E.
Chief Engineer, Department of City Planning

Pittsburgh, Pa.
October 26, 1933

Improvements in Sanitary Condition of Illinois River

TO THE EDITOR: The article on the Illinois River by Mr. Pearse, in the September issue, is excellent. Of particular interest would have been the inclusion of estimates of the improvements in river sanitation anticipated as a result of the great expenditures made in Chicago for sewage treatment, for the reduction of lake diversion, and for the canalization and pooling of the river channel.

It may be expected that the dams constructed on the stream will have a profound effect on the water from it, especially in the upper reaches, and will result in the delivery of a much purer product to the downstream sections. Natural purification agencies, such as sedimentation, oxygenation, and bio-chemical oxidation of organic matter, will be concentrated in the pools nearest the sources of pollution and, unless carefully controlled, may result in low oxygen content and even in increased nuisance conditions, accentuated by sludge deposits. Once the critical period has been passed, however, and recovery has begun, the remaining sections of the stream should benefit progressively, and a considerable stretch of it above Peoria and above the mouth should be restored to a more satisfactory sanitary condition.

Changes of this nature, as a result of canalization during low-water stages, have been observed in the Ohio River, as recorded in *Public Health Bulletin No. 204.* Although the urban population on the Ohio watershed above Cincinnati increased 86 per cent during the period from 1914 to 1930, the time of flow from Pittsburgh to Cincinnati was greatly lengthened, and the bacterial concentration and biochemical oxygen demand of the water at Cincinnati were both materially reduced. This resulted from the complete pooling of the stream channel during this period by means of the construction of some 20 movable dams.

A different situation was created in the pool into which the population of metropolitan Cincinnati, about 662,000, discharges its sewage. Here the dissolved oxygen content was seriously reduced and even eliminated for appreciable periods, and the bio-chemical oxygen demand and bacterial content increased. However, the river water immediately above Louisville was found to be in much better condition in 1930 than it had been in 1914, since this considerable period of time had permitted natural purification of the Cincinnati sewage by means of the intervening pools.

Another factor that may be of considerable importance is the effect of ice cover that may readily form on the wider expanses of relatively still water in the Illinois River pools. Of course such cover will retard re-aeration and thereby contribute to oxygen deficiency. Under certain conditions, such deficiency may extend considerable distances downstream, with a resultant destruction of fish life. The effect of such an ice cover was well illustrated in Lake Pepin, along the upper Mississippi River, 70 miles below Minneapolis. Here, during the winter months, the formation of a complete ice sheet resulted in a progressive drop of from over 80 per cent to 14 per cent in the saturation of dissolved oxygen in a 22-mile stretch of the lake (*Public Health Bulletin No. 203*). In Peoria Lake on the Illinois River this same effect of ice cover was observed during the winter of 1921–1922, when for short periods the oxygen saturation was seriously reduced in a stretch of the river 13 miles long.

Another factor that may result from discharging treated sewage into the pools of the Illinois River is the intensive development of the chlorophyll-bearing organisms, especially the green and blue-green algae. These water plants appear to thrive on the higher nitrates and as a result of the increased clarity effected by treated sewage, may become so prolific as to be a real nuisance, as was recently the case below Baltimore. In fact, Purdy refers to this abundance of algae in the Des Plaines River (*Public Health Bulletin No. 198*) below the point of discharge of the effluent from the Des Plaines River treatment plant.

J. K. Hoskins

Sanitary Engineer in Charge, Stream Pollution Investigations, U. S. Public Health Service

Cincinnati, Ohio
November 2, 1933

Need for Pollution Control on Lake Michigan

To the Editor: The article by Mr. Gorman on the pollution of the southern end of Lake Michigan, appearing in the September issue, discloses the excellent work that is being done in taste and odor control for the benefit of the Chicago Metropolitan District. For over 25 years the Calumet River region in Indiana has been a source of pollution to Lake Michigan and of danger to public health.

Several factors make the situation difficult. One is the lack of authority of the Indiana State Board of Health to prevent the discharge of industrial wastes from Lake County into Lake Michigan. Another is that the region in question has been financially prostrated and is apparently unable at the present time to spend money for necessary works.

The cause of the trouble is twofold, sewage pollution and industrial wastes from Indiana. Concerted action is needed, primarily for the relief of the Indiana municipalities concerned, but also for those in Illinois.

The hydraulic situation is complicated. In a state of nature the Calumet River had a maximum discharge of approximately 12,000 cu ft per sec and a dry flow as low as 200 cu ft per sec. The Burns ditch cuts off about one-half the watershed. In dry weather the greater part of the flow in the Grand Calumet River, normally as much as 600 cu ft per sec, originates from the Gary steel mills. This flushes the sewage of Gary, East Chicago, and part of Hammond into the lake through the East Chicago Ship Canal, leaving the remainder of the flow to pass west to the Calumet River and thence to the Calumet-Sag Channel of the Sanitary District of Chicago.

By the opening of the Calumet-Sag Channel, the direction of flow of the Calumet River at South Chicago was reversed. For several years past there have been practically no reversals of sufficient extent to affect the southerly water-works intakes of Chicago. When the diversion from Lake Michigan is reduced, at the end of 1938, to conform with the decree of the U. S. Supreme Court, there will be frequent ouflows at South Chicago if no change comes about in the Indiana situation in the meantime. Likewise, pollution will appear in the Calumet-Sag Channel, which has so far not been considered in the picture, since no provision has been made for the Indiana municipalities.

The various authorities concerned are cooperating to find a solution. They hope that in the next five years there will be accomplished results which the past 25 years have failed to produce. The situation is most unfortunate for the Indiana towns involved; particularly Hammond, where chlorination is the sole defense. Whiting and East Chicago have water-filtration plants and, by careful control, have thus far been able to cope with the situation.

If the problem can be worked out in a friendly, cooperative way by state and municipal officials and the industries concerned, the result will be a monument to all who have contributed to the solution.

Langdon Pearse, M. Am. Soc. C.E.

Sanitary Engineer, the Sanitary District of Chicago

Chicago, Ill.
November 1, 1933

Slow Traffic By-Pass for Two-Lane Highways

To the Editor: A short section of widened roadway every few miles along two-lane highways would enable slow-moving vehicles to move to the right of the highway a distance sufficient to permit fast traffic behind them to pass. The operation of such a spur, or additional short roadway, is shown in Fig. 1.

Such an arrangement would greatly increase travel on a two-lane highway. It would add a tremendous factor of safety by eliminating the necessity for fast traffic to pass slow vehicles on the opposite traffic lane. These widened sections on two-lane highways would produce traffic facilities almost equal to those of a four-lane roadway.

Many two-lane highways are badly in need of something to facilitate the movement of traffic. This proposed plan would entail a wise expenditure of money at the present time. Employment would be stimulated in the very fields where the need is greatest.

The highway department could adopt the rule that slow-moving traffic should use these by-passes, thus permitting fast traffic to pass.

A. W. Robertson

Pittsburgh, Pa.
November 13, 1933

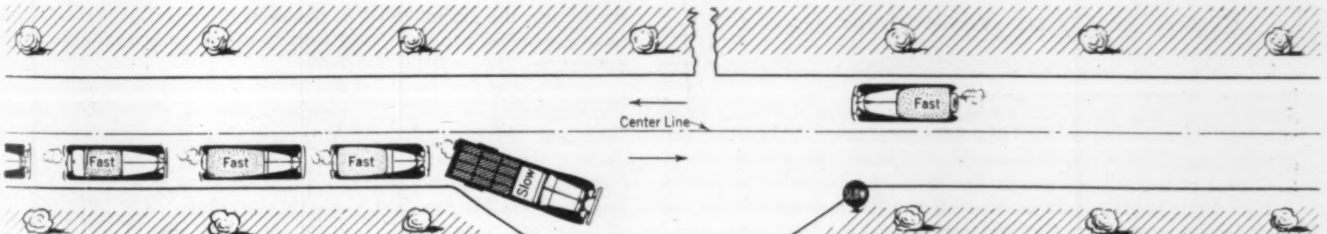


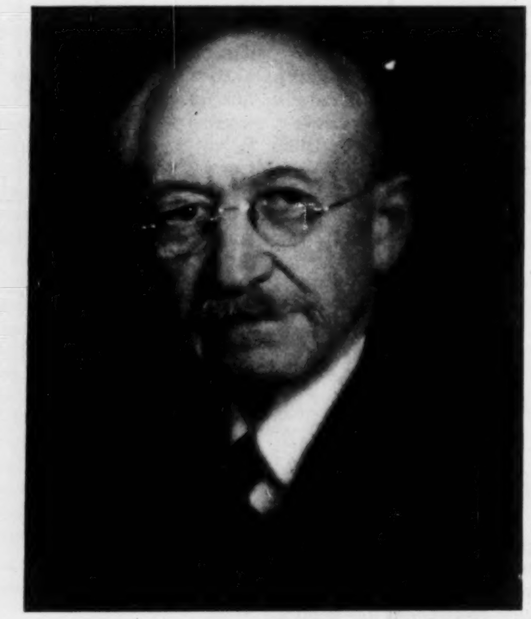
Fig. 1. Diagram of Operation of Slow-Traffic By-Pass

SOCIETY AFFAIRS

Official and Semi-Official

Dean Turneaure Elected to Honorary Membership

Two young men who were born on farms near each other in northern Illinois went in the same year to Cornell University, each having won a scholarship in mathematics. They were roommates during part of their college life, and they wrote their thesis together. Soon after graduation one of these young men went to Iowa State College at Ames; the other to the University of Wisconsin, both to take up the teaching of engineering. Each became dean of the engineering college of his respective institution, and each has continued in his respective college to the present time. The former, Anson Marston, served as President of the Society in 1929; the latter, Frederick E. Turneaure, has recently been elected to Honorary Membership.



Frederick Eugene Turneaure, Hon. M. Am. Soc. C.E., Dean, College of Mechanics and Engineering, University of Wisconsin

In this election the Society takes pleasure in honoring an eminent engineer who has given much not only to it but also to the entire profession of engineering. To the illustrious group of engineers who comprise the list of Honorary Members the name of Dean Turneaure has been added. Certain it is that this notable group will welcome to its ranks this man who can serve but to heighten the regard in which it is held by engineers throughout the world.

A short biographical sketch can touch only the peaks of a busy career. Frederick Eugene Turneaure was born on a farm near Freeport, Ill., July 30, 1866. He graduated from Cornell University in 1889, with the degree of Civil Engineer. In 1905 the University of Illinois conferred on him the honorary degree of Doctor of Engineering. In the years 1895 and 1896 he studied engineering abroad. His life-long career as a teacher began in 1890, when he was appointed an instructor in Washington University, which position he held until 1892. In that year he became Professor of Bridge and Sanitary Engineering at the University of Wisconsin, and has been connected with that university ever since, having been made dean of the Engineering School in 1903.

He served as city engineer of Madison, Wis., from 1902 to 1904, at the time when the first sewage treatment works were installed. As a member of the Wisconsin Highway Commission from 1911 until it was discontinued in 1929, he played a large part in developing sound policies of highway administration in the state.

He is known as an authority on the theory of structures, on the theory and practice of reinforced concrete, and in the field of water supply. Among his published works are: *Theory and Practice of Modern Framed Structures* (3 vols., 1893), written in collaboration with J. B. Johnson and C. W. Bryan; *Public Water Supplies* (1900) in collaboration with H. L. Russell; and *Principles of Reinforced Concrete Construction* (1907) in collaboration with E. R. Maurer. He has also been active in many experimental investigations, including reports on "Impact in Steel Railway Bridges" (Proceedings for December 1929), and "Steel Column Research," which was published in the 1933 Transactions of the Society. The report, *Experiments on Reinforced Concrete Beams*, appeared as a bulletin of the Engineering Experiment Station of the University of Wisconsin.

In 1930, the American Concrete Institute presented to Dean Turneaure the Turner gold medal, "for distinguished service in formulating sound principles of reinforced concrete design." Dean Turneaure was elected an Affiliate of the American Society of Civil Engineers in 1897, became an Associate Member in 1902, and in 1913 was transferred to the grade of Member. He has done valuable work for the Society and for the civil engineering profession on a large number of committees. These include the first Joint Committee on Concrete and Reinforced Concrete; the Committee on Stresses in Railroad Track; the Committee on Impact in Highway Bridges; the Committee on Bridge Design and Construction; and the Committee on Engineering Education. He has served as chairman of the Committee on Research, and of the Special Committee on Steel Column Research, whose excellent final report has just appeared in the 1933 Transactions. On many other subjects also, he has been a frequent contributor to the publications of the Society.

His membership in other societies includes the American Association for the Advancement of Science; the Society for the Promotion of Engineering Education (president, 1908–1909; and service on the Board of Investigation and Coordination); the American Railway Engineering Association; the Western Society of Engineers; and the Wisconsin Engineering Society. From 1909 to 1910 he was president of the latter organization.

At the presentation of this distinguished honor during the Annual Meeting in January more can be said of the qualities of mind, the strength of character, and the friendliness of disposition which mark Dean Turneaure as the successful administrator and teacher of engineering that he is.

Award of Alfred Noble Prize for 1933

For the first time since its establishment in 1929, the Alfred Noble Prize has been awarded to a civil engineer—C. Maxwell Stanley, Jun. Am. Soc. C.E., for his paper, "Study of Stilling Basin Design," in the November 1932 Proceedings. This prize perpetuates the name and achievements of the late Alfred Noble, Past-President of the Society and of the Western Society of Engineers.

The award is made to a member in any grade of one of the four Founder Societies or of the Western Society of Engineers, for a technical paper of special merit accepted by any of these societies for appearance, in whole or in abstract, in their respective technical publications. At the time the paper is accepted in practically its final form, the author must be not more than thirty years old. If in any year no paper deemed worthy of award is available to the committee, the award is not made.

In 1931, the first award of the Alfred Noble Prize went to a mining engineer; in 1932 the recipient was an electrical engineer. This year the committee of five, consisting of a representative of each of the sponsoring societies, unanimously chose Mr. Stanley. The Society's representative on the committee of award is Charles M. Spofford, M. Am. Soc. C.E., its chairman. The prize consists of $500 and a certificate bearing the signatures of the President and Secretary of the Society, which acts as trustee of the fund. Formal presentation will take place in January 1934, at the Annual Meeting of the Society in New York.

Valuable Papers on File in the Library

IN THE May 1933 issue of CIVIL ENGINEERING appeared a list of papers that had recently been placed for reference in the Engineering Societies Library. Since that time other papers have accumulated in the files of the Committee on Publications. Although these papers contain much of interest and value to the profession, it has not been found practicable to publish them. However, at the request of the committee, the authors have given their permission for the Society to file these papers and have prepared brief résumés of their contents.

Some of these résumés follow; others will appear in later issues of CIVIL ENGINEERING. The originals of the papers listed here have been filed in the Engineering Societies Library, where they will be available to any one who is interested. An estimate of the cost of photostatic copies of them may be obtained on direct application to the Engineering Societies Library, 29 West 39th Street, New York, N.Y.

REPORT ON DEVELOPMENT OF THE EASTERN SHORE OF SAN FRANCISCO BAY

RALPH A. BEEBEE, M. Am. Soc. C.E., "Report on Development of the Eastern Shore of San Francisco Bay" (about 26,000 words, plus appendixes of 20 pages, tables, and 23 plans and diagrams). This summary of harbor matters pertaining to certain cities located on the eastern shore of San Francisco Bay includes original studies on tides, currents, breakwater design, and commercial possibilities. Its purpose is to codify past studies, supply new data, and make a quantitative analysis therefrom.

INTEGRAL ARCH ACTION

GEORGE E. BEGGS, M. Am. Soc. C.E., "Integral Arch Action" (about 5,000 words and 10 illustrations). French engineers have shown Americans that remarkably light and efficient concrete bridges can be designed by considering the spandrel columns and floors as integral with the ribs. To avoid laborious computations, celluloid models have been studied with deformeter apparatus. They show the nature and variations in the structural action and particularly the great reductions of stress due to integral construction.

THE SANITATION OF ENGINEERING AND CONSTRUCTION CAMPS

DALFERES P. CURRY, M.D., "The Sanitation of Engineering and Construction Camps" (about 5,000 words of text). The paper deals exclusively with sanitation in construction camps in the American tropics. The first essential is water of suitable quality and sufficient quantity, with necessary provisions for making it safe. Details of adequate food supply are described, and particularly the disposal of all camp wastes, both sewage and garbage. Advice on the treatment and control of tropical diseases involves material on such maladies as malaria, yellow fever, hookworm, smallpox, and pneumonia. Methods of protection against mosquitoes, vermin, and reptiles are concretely described and also their relation to medical and dispensary service.

HIGHWAY CONSTRUCTION IN THE TROPICS

JOSÉ RAMON GUIZADO, Assoc. M. Am. Soc. C.E., "Highway Construction in the Tropics" (4,000 words of text). This paper is based on experience in road construction in the Republic of Panama. Beginning with the item of government financing, the paper describes methods of surveying and locating, the obtaining of rights of way, determination of grades and widths, procedure in excavation and grading, and details of drainage structures. Other items concern protection from erosion, construction of wearing surfaces, and costs in the Republic of Panama.

Index to Volume 3 Bound in This Number

WITH THE PUBLICATION of the December 1933 number, the third volume of CIVIL ENGINEERING is completed. Very appropriately, the index to the entire volume will be found at the end of this issue. The difficulties involved in presenting a complete volume index concurrently with the appearance of the final number of the volume are more than offset by the distinct advantages to those readers and libraries who may wish to bind their issues immediately. The index is to be found on the final pages of this number, adjacent to the back cover.

In order that it may be easily transferred to its proper place at the beginning of the bound volume, the index has been printed on a completely separate form. By opening the binding staples at the back of this issue, the form can be released intact without the cutting of any pages. For those who wish to separate the volume and bind it in two parts, with an index at the beginning of each part, reprints of the index are available at Society Headquarters on request, at the price of 15 cents each.

No effort has been spared to make the index complete and of practical usefulness to readers. It consists of two parts, a name index and a subject index. Articles and items may be found either under their subjects in the subject index, or in the name index under the name of the author or person mentioned. To make the subject index more useful, many cross references have been included.

The page at the beginning of the index not only serves as a cover for the index itself but also provides an appropriate title page for the bound volume. It will be noted that throughout the volume the advertising pages have been numbered independently. Thus, if covers and advertisements are removed before binding, the paging of the articles and departments will be consecutive throughout the volume.

Professional Records of Candidates for Office

HARRISON P. EDDY

BORN AT Millbury, Mass., Harrison P. Eddy was graduated from Worcester Polytechnic Institute in 1891, with the B.S. degree. From 1891 to 1892 he was superintendent of the sewage treatment plant at Worcester, Mass., and from 1892 to 1907, superintendent of the Worcester Sewer Department, in charge of the construction, maintenance, and operation of sewers and sewage treatment plant, all work being performed by direct labor. From 1907 to date, he has been a partner in Metcalf and Eddy, a Boston engineering firm, specializing in sanitary engineering. He has been consulting engineer to some seventy-five municipalities, on problems of water supply, sewerage, drainage, water filtration, sewage purification, and refuse disposal, and to cities and manufacturers on the treatment and disposal of industrial wastes.

With the late Leonard Metcalf, M. Am. Soc. C.E., he is co-author of *American Sewerage Practice*, in three volumes, and of a textbook, *Sewerage and Sewage Disposal*. He is the author of a number of technical papers. Mr. Eddy has been a member of commissions of engineers who advised on problems of sewage disposal and water supply for Milwaukee, Wis.; the comparative costs of contract and day labor in sewer construction, in New Orleans, La.; sewage treatment for the north side of the Sanitary District of Chicago; sewage disposal for Detroit, Buffalo, and Pittsburgh; and additional water supply for Rochester, N.Y. He was a member of the Engineering Board of Review of the Sanitary District of Chicago.

At present he is serving on boards of engineers on the problems of sewage disposal in Washington, D. C., Toronto, Ont., and Portland, Ore. He is a member of the Technical Board of Review of the Public Works Administration. He is a member of the Boston Society of Civil Engineers, of which he was president in 1914; of the American Institute of Consulting Engineers, of which he was vice-president in 1926; of the American Water Works Association; the American Public Health Association; the American Society for Testing Materials; the American Chemical Society; the Union and Engineers clubs of Boston; the Engineering Institute of Canada; the Institution of Civil Engineers (London); and the Engineers Club of New York.

O. H. AMMANN

O. H. AMMANN was born on March 26, 1879, in Switzerland. He received his education in that country, graduating in 1902 from the Swiss Federal Polytechnic Institute in Zurich, with the degree of Civil Engineer. His early experience in Europe embraced survey work on railroad construction, structural steel design and shop work, and the design and construction of reinforced concrete structures.

From 1904 to 1912 he was engaged in various capacities, principally in connection with the design of bridges in the United States. As Principal Assistant to Gustav Lindenthal, Hon. M. Am. Soc. C.E., and as Assistant Chief Engineer of the New York Connecting Railroad, he aided in the design and construction of the Hell Gate Bridge and approaches in New York City, the Sciotoville Bridge across the Ohio River, and in studies for the proposed bridge across the Hudson River at 57th Street, New York, N.Y.

Since 1925 he has been connected with the Port of New York Authority as chief engineer of bridges and later as chief engineer in general charge of the planning and construction of such projects as the Outerbridge Crossing and the Goethals Bridge across the Arthur Kill, the Bayonne Bridge across the Kill van Kull, the George Washington Bridge across the Hudson River, and others. Since 1929 he has also served as a member of the Board of Engineers in charge of the construction of the Golden Gate Bridge in San Francisco.

He is a director of the Metropolitan Section of the Society, and a member of the American Institute of Consulting Engineers, the American Railway Engineering Association, the American Society for Testing Materials, the Institution of Civil Engineers (London), and the Engineers Club of New York.

OFFICIAL NOMINEES—1934

For President, Harrison P. Eddy, of Boston, Mass.

For Vice-Presidents:

Zone I, John P. Hogan, of New York, N.Y.
Zone IV, H. D. Dewell, of San Francisco, Calif.

For Directors:

District 1, O. H. Ammann and C. E. Trout, both of New York, N.Y. (two to be elected)
District 2, Frank A. Barbour, of Boston, Mass.
District 6, Thomas J. Wilkerson, of Beaver Falls, Pa.
District 10, Frederick H. McDonald, of Atlanta, Ga.
District 13, B. A. Etcheverry, of Berkeley, Calif.; and T. E. Stanton, Jr., of Sacramento, Calif. (one to be elected)

Results of the final ballot will be announced at the Annual Meeting in January 1934

FRANK A. BARBOUR

BORN IN St. John, New Brunswick, on May 5, 1870, Frank A. Barbour was graduated from the University of New Brunswick. After several years experience in railroad location and construction in Canada and New England, he became an assistant in the Boston Water Department under the late Desmond FitzGerald, Past-President of the Society. Following this, he was for six years engaged in the design, construction, and operation of one of the early New England sewage disposal plants, that at Brockton, Mass.

He remained there in charge of the chemical laboratory until 1898 when, in partnership with F. H. Snow, M. Am. Soc. C.E., he opened an office in Boston for private practice. Since the retirement of Mr. Snow in the same year he has continued in private practice, specializing in problems of water supply, water purification, sewerage, sewage disposal, and the appraisal of water properties. During the World War he served as supervising engineer at Camp Devens.

Recent engagements of interest include appraisals of the property of the Passaic Consolidated Water Company, the Long Island Water Corporation, and the New Rochelle Water Company. In association with W. E. Fuller, M. Am. Soc. C.E., he was responsible for the reconditioning of the Passaic consolidated system; and, in collaboration with John H. Gregory, M. Am. Soc. C.E., he prepared a report for the Water Policy Commission of New Jersey on the subject of a supply for the Northern Metropolitan District of that state. He gave testimony in the interstate case of Connecticut vs. Massachusetts for the diversion of water and investigations and appraisals of water power and process water damages resulting from the diversion of the Ware and Swift rivers by the Metropolitan District Water Supply Commission of Massachusetts.

He is a member of the Engineering Institute of Canada, the American Water Works Association, the American Public Health Association, and of the Executive Committee of the American Society for Testing Materials. Also, he is a former president of the New England Water Works Association and of the Boston Society of Civil Engineers.

HENRY D. DEWELL

HENRY D. DEWELL was born in Springfield, Ohio, October 24, 1881. He was graduated from the University of California in 1906, with the degree of B.S. in civil engineering. Following his graduation, he was employed by Howard and Galloway, architects and engineers of San Francisco, their work consisting not only of building construction, but also hydro-electric design and construction and general engineering work. In 1907 the firm was appointed supervising architects of the Alaska–Yukon Pacific Exposition, and Mr. Dewell spent the period from September 1907 to January 1909 in Seattle as structural engineer for the firm on the design of the structural frames for the exposition buildings and for buildings for the University of Washington. From 1909 to 1912 he was in the employ of Galloway and Markwart, consulting engineers of San Francisco, serving in both office and field in responsible capacities on general engineering work, comprising reports, surveys, plans and specifications, and supervision of the construction of buildings, bridges, highways, irrigation and hydro-electric projects.

Mr. Dewell, from 1912 to 1915, was chief structural engineer, assistant superintendent of building construction, and then engineer of domestic water supply and distribution for the Panama Pacific International Exposition held in San Francisco. At the close of the exposition, he entered private practice as a civil and consulting engineer and has continued in private practice to date. In 1919 and 1920, he lectured at the University of California.

Mr. Dewell was a member of the Board of Direction of the Society for the period 1925–1927, chairman of its committee on Local Sections, and a member of its Committee on the Effect of Earthquakes on Engineering Structures. In 1930 he was president of the San Francisco Section.

Mr. Dewell is vice-president of the California State Board of Registration for Civil Engineers. He is a member of the Seismological Society of America, having been treasurer and a member of the publication committee. He is a member of the Advisory Committee on Vibration Research at Stanford University, the Structural Engineers Association of Northern California, the American Concrete Institute, the American Society for Testing Materials, and the National Committee on Wood Utilization. He is northern technical editor of the Uniform Building Code, California edition.

BERNARD A. ETCHEVERRY

On June 30, 1881, Bernard A. Etcheverry was born in San Diego, Calif. In 1902 he was graduated from the University of California, receiving the degree of B.S. in civil engineering. He then became an instructor in civil engineering at the university for a year, after which he served as Associate Professor at the University of Nevada for two years, returning to the University of California in 1905 to become Assistant Professor of Irrigation. From this position he was promoted to that of Associate Professor and, in 1917, became Professor of Irrigation and Drainage, which position he has held to date.

During his early connection with the University of California, he was employed part of the time on irrigation investigations for the U. S. Department of Agriculture. Since 1910 he has served as consulting engineer on several irrigation projects in California and British Columbia, and in litigation work on suits involving irrigation and water supply problems for the Pacific Gas and Electric Company, the California–Oregon Power Company, the City of San Francisco, and several irrigation districts and companies. He has also served on the board of consulting engineers for several water-storage and flood-control districts in California, and for the California State Department of Public Works; and has been one of the commissioners of assessment for several reclamation and drainage districts and for the State Reclamation Board in connection with the Sacramento River flood-control project.

He is the author of *Irrigation Practice and Engineering* and *Land Drainage and Flood Protection.* With Elwood Mead, M. Am. Soc. C.E., he was selected by the Society to prepare the joint paper on "Irrigation in the United States," presented at the World Engineering Congress held in Japan in October 1929.

In addition to being a former president of the San Francisco

Section of the Society, he is a former secretary of the Irrigation Division of the Society and a member of the Society's Research Committee on Irrigation Hydraulics.

John P. Hogan

Born in Chicago, Ill., on June 12, 1881, John P. Hogan was educated at the University School, Chicago, and at Harvard University. From the latter he was graduated in 1903 with the degree of A.B. and received the degree of S.B. in 1904.

During 1904 and a part of 1905, he was employed on the construction of the original subway in New York, and in the fall of 1905 became resident engineer on construction work for the Brooklyn Rapid Transit Company. In March 1906, Mr. Hogan became an assistant engineer on the Catskill Aqueduct with the New York Board of Water Supply and served continuously with that organization until 1920 as Senior Assistant Engineer and Division Engineer of the Esopus and the Conduit and Reservoir divisions.

At the outbreak of the World War he was called into service as Captain of Engineers and assigned to the 11th Engineers, with whom he left for France early in 1917. He served two years in France in grades from captain to lieutenant-colonel on the general staff. He received the Distinguished Service Medal, the Legion of Honor, the Conspicuous Service Cross (New York State), and the Order of the Purple Heart.

On his return, Mr. Hogan was for a short period Acting Deputy Chief Engineer of the Board of Water Supply, and in January 1920 entered the consulting firm of Parsons, Klapp, Brinckerhoff and Douglas, of which he became a member in 1926. He has participated with the firm in a number of large engineering and construction projects. His personal work has consisted largely of the development and utilization of electric power. He was a member of the Marketing Board of the St. Lawrence Power Development Commission and consulting engineer to the U.S. Government on the power survey of the Delaware River.

In Society affairs Mr. Hogan has been active, having been Director of the Society (1920–1923) and president of the Metropolitan Section. During the past two years he has been chairman of the Public Works Committee and was active in the passage of the public works legislation of the Reconstruction Finance Act and the National Industrial Recovery Act. He is a member of the Assembly and Administrative Board of the American Engineering Council and is at present vice-chairman of the Code Committee of the Construction League.

Frederick H. McDonald

Born in Charleston, S.C., August 16, 1892, Frederick H. McDonald received the bachelor of science degree in electrical and mechanical engineering at Clemson College, then did post-graduate work at the University of Pittsburgh in commercial law, banking, and corporation finance. Prior to the World War, he was connected with the Westinghouse Electric and Manufacturing Company and the Hope Engineering and Supply Company. During the period 1917–1921, he was First Lieutenant, 105th Engineers, 30th Division, U.S. Army, being seriously wounded in the Hindenburg Drive, in September 1918, and discharged with permanent disability in February 1921.

After demobilization, he became connected with Lockwood Green and Company, Engineers, of Atlanta, on plant layout and industrial surveys. During 1923 and 1924 he was managing director of the Georgia Industrial Bureau, for which he made economic analyses of industrial plant locations. From that time he was responsible head of McDonald and Company, engineers and architects, engaged in a general practice that has included hydro-electric planning and studies and the construction of a series of theaters for Paramount-Publix Corporation, the new Union Station in Atlanta, and other engineering, industrial, and architectural projects. In the latter part of 1932 he began practice as a consulting engineer in Atlanta, dealing largely in the field of engineering-economics and finance. He was local Advisory Engineer to the Reconstruction Finance Corporation, 1932–1933.

He was secretary of the Georgia Section for three years and president in 1925. Mr. McDonald was instrumental in the organization of the Engineering-Economics and Finance Division of the Society, which was authorized by the Board of Direction in January 1931. Since that time he has been secretary of the Division. He is a member and secretary of the Division's Committee on Valuation Procedure and Depreciation and is a member of the Society's Joint Committee on Substructure Engineering in cooperation with the Associated General Contractors of America. At recent meetings of the Society he has presented a number of papers, dealing largely with the economic phases of engineering. He is also a member of the American Engineering Council's Committee on the Relation of Production, Distribution, and Consumption, which is now making a study of our national economic structure. In 1931 he developed a theory of business stabilization in a brochure entitled *Compulsory Stabilization Reserve Funds*. He has recently presented another brochure on *Why Public Works for Recovery*, dealing comprehensively with present-day economic problems and the function of public works in the solution of our national economic difficulties.

T. E. Stanton, Jr.

A native of California, T. E. Stanton, Jr., was born in Los Angeles on May 31, 1881. He graduated from the University of California in 1904 with the degree of B.S. in mining engineering. After several months in the employ of the Southern California Edison Company, and later in the Los Angeles office of the Salt Lake Railroad, he entered the Los Angeles City Engineer's Office in the spring of 1905. He was employed there for the following seven years as assistant engineer on the design of sanitary and street-paving projects, including the preparation of specifications.

In the spring of 1912, he entered the employ of the California State Highway Department under the jurisdiction of the State Highway Commission, and has remained continuously in the employ of the California Division of Highways since that date. He has served in the capacities of Assistant Division Engineer and Assistant State Highway Engineer, and is now Chief of the Department of Materials and Research.

He has been active in technical matters connected with the construction of bridge and highway pavements, including extensive research, particularly in the development of portland and asphaltic cement specifications, and of information and tests on steel, portland cement, and asphaltic cement construction.

He is a former president of the Sacramento Section of the Society, a member of the American Association of State Highway Officials, the American Concrete Institute, and the American Society for Testing Materials. He was also chairman of the local committee in charge of the 1930 Spring Meeting of the Society when it was held in Sacramento, and is a member of various committees of the previously mentioned societies.

Charles E. Trout

A native of Canada, Charles E. Trout was born near Clarksburg, Ontario, on November 27, 1871. He graduated from the Massachusetts Institute of Technology in 1896 and received his early engineering training in Boston under Edgar S. Dorr, M. Am. Soc. C.E., at that time Chief Engineer of the Boston Sewer Department.

Early in 1900, Mr. Trout entered the service of the Department of Docks and Ferries, City of New York, and remained there, except for a short period of service with the Commission on Additional Water Supply of that city, until the end of 1917, first as draftsman, then as assistant engineer and division engineer. For 12 years he was in charge, under Charles W. Staniford, M. Am. Soc. C.E., chief engineer, of all dredging, surveys, and preparation of new plans for improving the water front.

In 1918 and 1919 he had charge, for the Turner Construction Company, of the design and construction of the water-front structures at the Brooklyn Army Supply Base. At the completion of this project, Mr. Trout joined the staff of Henry Steers, Inc., contracting engineers of New York, for whom he designed and constructed many water-front structures. From 1929 to 1932 inclusive, he was secretary of the company and general manager of its sand and gravel business.

EIGHTY-FIRST ANNUAL MEETING, January 17–20, 1934, in New York, N.Y. Complete Program in January Issue.

He is at present vice-president of George B. Spearin, Inc., dock-building contractors. For the past 12 years Mr. Trout, in addition to his business activities, has been in practice as a consulting engineer on water-front and harbor problems.

In the field of Society affairs he has served as chairman of the Annual Meeting Committee and has been treasurer of the Metropolitan Section.

THOMAS J. WILKERSON

ON NOVEMBER 20, 1868, Thomas J. Wilkerson was born on a farm near Plattsburg, Mo. He received his technical training at the University of Missouri, graduating in 1890 with the degree of Civil Engineer. From 1890 to 1896 he was with various bridge companies. From 1896 to 1901 he was with the Keystone Bridge Works of the Carnegie Steel Company, where he was in charge of making detail drawings for various structures, including the steel work for the first subway built in New York City, and bridges across the Allegheny and Monongahela rivers.

From 1901 to 1904 he was assistant to the division manager of the Pittsburgh division of the American Bridge Company. In 1904, upon the consolidation of the Eastern and Pittsburgh divisions of the operating departments, he was transferred to the estimating and designing division of the engineering department. In June 1909 he accepted a position as bridge designer in the Engineering Bureau of the Department of Public Works, City of Pittsburgh, and in January 1912 was appointed division engineer in charge of the design, construction, and maintenance of all city bridges.

In June 1917 he resigned his position with the city to become chief engineer of the Penn Bridge Company of Beaver Falls, Pa., where he had charge of all contracting and engineering work. In June 1920 he left this position to open an office as consulting engineer. In February 1924 he was retained as consulting engineer by the Bureau of Bridges, Department of Public Works, Allegheny County, Pennsylvania. He proposed the type, directed the design, and supervised the preparation of the plans for the Sixth Street, Seventh Street, and Ninth Street bridges across the Allegheny River in Pittsburgh, and was consultant on all the bridges constructed by the county between 1924 and 1932. In 1925 he was retained by Beaver County, Pennsylvania, to design and supervise the construction of the bridge across the Ohio River at Ambridge, Pa., and in September 1927 he served the county in a similar capacity in the construction of the bridge across the Ohio River between Rochester and Monaca.

He was one of the original organizers of the Pittsburgh Section of the Society. He is also a member of the Engineers' Society of Western Pennsylvania and served one year as chairman of the structural section of that society. He is also a member of the American Society for Testing Materials.

Appointments of Society Representatives

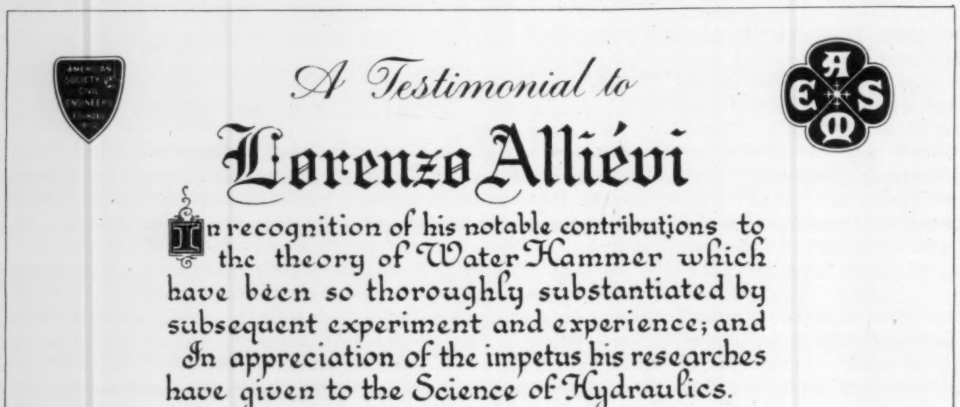
W. W. DEBERARD, M. Am. Soc. C.E., was appointed to represent the Society at the National Conference on Low-Cost Housing, held in Cleveland, October 25–27, 1933.

CHARLES T. MAIN, M. Am. Soc. C.E., and CHARLES P. PRICE, Affiliate Am. Soc. C.E., have been appointed to serve as Society representatives at the winter meeting of the American Association for the Advancement of Science, to be held in Boston from December 27, 1933, to January 2, 1934.

CHARLES F. LOWETH, Past-President Am. Soc. C.E., and J. VIPOND DAVIES and HARRISON P. EDDY, Members Am. Soc. C.E., have been appointed to represent the Society on the Engineers' Council for Professional Development, from October 1933 to October 1936, the term of one expiring each year in the order in which their names are listed here.

Achievements of Lorenzo Allievi

JOINTLY by the Society and the American Society of Mechanical Engineers, a testimonial in the form of an engrossed and illuminated certificate is being presented to Lorenzo Allievi, noted Italian hydraulic engineer, for his work in the field of hydraulics, and more especially for his investigations of water hammer. Notes on the "General Theory of Water Hammer," the result of Mr. Allievi's researches, begun about 1902, were published in 1912, and ten years later were translated into English by Eugene E. Halmos, M. Am. Soc. C.E. This translation was made available to the profession by the Society in 1926 and, although now out of print, is available in most technical libraries. The researches of Mr. Allievi continue, and are held in high regard by the profession, as is evidenced by the presentation of this certificate to him.



A Testimonial to

Lorenzo Alliévi

In recognition of his notable contributions to the theory of Water Hammer which have been so thoroughly substantiated by subsequent experiment and experience; and In appreciation of the impetus his researches have given to the Science of Hydraulics.

THE AMERICAN SOCIETY OF CIVIL ENGINEERS

Alonzo J. Hammond PRESIDENT

CHR. POWER DIVISION

George T. Seabury SECRETARY

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

A. A. Potter. PRESIDENT

S. Logan Kerr. CHR WATER-HAMMER DIVISION

CHR. HYDRAULIC DIVISION

Calvin W. Rice SECRETARY

Born in Milan in 1856, Lorenzo Allievi studied at the University of Rome and in 1879 received the degree of Civil Engineer. He then entered the Genio-Civile and was sent to Germany to study railways. After teaching for a time in the Polytechnic Institute of Rome, he returned to railroad building, and in Sicily contracted a dangerous illness, which made him an invalid for a year (1892). Next he became head of the Risanamento of Naples, a huge housebuilding enterprise, which position he held for seven years, during a critical financial period. Returning to Rome in 1901, he interested himself in industry, especially its hydro-electric and electro-chemical phases.

The breaking of a large pipe in a carbide factory at Terni turned his attention to the subject of water hammer phenomena, on which there was a dearth of technical information. His basic studies of this branch of hydraulics have made available results that are considered epoch-making.

In Washington, D.C., at an appropriate ceremony, the certificate reproduced here has been presented to the Italian Ambassador, for formal transmittal to Mr. Allievi.

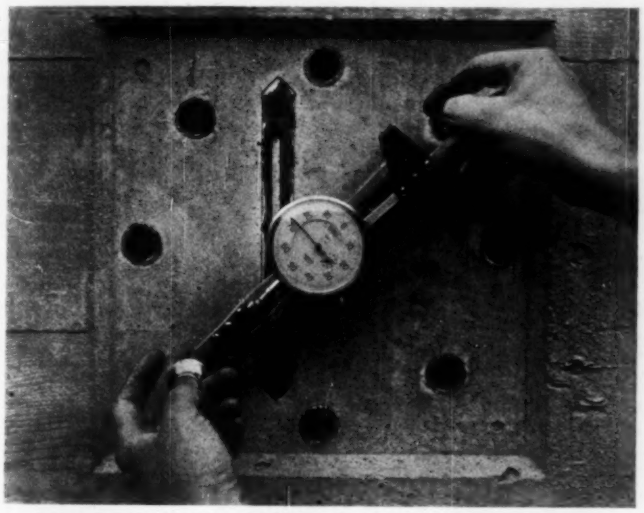
A Preview of Proceedings

Final revisions in two papers, announced to appear in the November issue of PROCEEDINGS, *have made it necessary to postpone their printing to a later date. These two papers are: "Formation of Floc by Means of Ferric Coagulants," by Edward Bartow, M. Am. Soc. C.E., A. B. Black, and Walter E. Sansbury; and "Modifying the Physiographical Balance by Conservation Measures," by A. L. Sonderegger, M. Am. Soc. C.E. They will appear in the December* PROCEEDINGS.

Experimental research on the comparative behavior of the Calderwood Dam and a scalar model of it has progressed to a point where the results can be presented to the profession. They will appear in the December number of PROCEEDINGS. *A paper on stream flow and the latest progress report of the Committee on Wind Bracing will comprise the remainder of the December number.*

MODEL OF CALDERWOOD ARCH DAM

A DECIDEDLY informative paper, by A. V. Karpov and R. L. Templin, Members Am. Soc. C.E., on the subject of models is presented in the forthcoming PROCEEDINGS, in which the authors report the progress of their arch-dam studies. As distinguished from papers that delve into the theory of similitude, this paper shows the practical applications of strict theories. In fact, it has handbook characteristics that would seem to be decidedly valuable to any one contemplating the construction of engineering models of an arch dam.



TAKING A STRAIN-GAGE READING ON THE DOWNSTREAM FACE OF THE CALDERWOOD DAM

For their subject the authors take the prototype and the model of the Calderwood arch dam south of Knoxville, Tenn., on the Little Tennessee River. The paper is provided with admirable cross references, so that students of the subject, by reading the paper and its supplementary references, will have access to much of the more important scientific thought on this subject in recent years. A brief description of the building of the model of the Calderwood Dam, by Messrs. Karpov and Templin, appeared in the January 1932 number of CIVIL ENGINEERING.

For the mathematical derivation of the similarity conditions and for the specifications that the material for an arch-dam model must meet in order to satisfy these conditions, readers are referred to other papers written on this subject by the authors. The present paper emphasizes theoretical considerations, such as the condition governing the method of loading the model, the conditions governing the property of the material used in the model, and those governing the method of constructing the model. Measurements made on Calderwood Dam, prototype and model, are presented and discussed, as is the comparative behavior of model and prototype as regards deflection, strains, and stresses. The three appendixes included describe in a practical manner the results of laboratory and analytical studies to determine the properties of the materials used in the prototype and in the model.

AN APPROACH TO DETERMINATE STREAM FLOW

Another paper in the forthcoming issue is by Merrill Bernard, M. Am. Soc. C.E., already known to members of the Society through his paper on "Formulas for Rainfall Intensities of Long Duration," which was published in Volume 96 of TRANSACTIONS (1932). His present paper is concise and timely and contains a definite extension of engineering thought as applied to the analysis of a problem of broad interest to the engineering profession. An attempt was made in this paper to apply newer theories to information available in the Weather Bureau and the Geological Survey, particularly with respect to data gathered for the State of Ohio.

Mr. Bernard has developed a procedure which is based on the theory of the unit graph introduced by LeRoy K. Sherman, M. Am. Soc. C.E., in an article in *Engineering News-Record* in 1932. The paper points to the practicability of an analytical treatment of stream-flow problems and demonstrates the successful use of data offered by the U. S. Weather Bureau and the Geological Survey.

THIRD PROGRESS REPORT OF SUBCOMMITTEE ON WIND BRACING

Following the publication of its First and Second Progress Reports, printed in CIVIL ENGINEERING for March 1931 and in PROCEEDINGS for February 1932, respectively, the Structural Division's Subcommittee on Wind Bracing in Steel Buildings submitted an extensive Third Progress Report at the Annual Meeting of the Society, in January 1933. With a view to facilitating discussion of the subject and thereby aiding the subcommittee in its work, this report will be published in PROCEEDINGS for December.

New points of view are brought out in reply to those who contributed to the discussion of the Second Progress Report, particularly as regards the factor of safety attained when designing for the combination of wind with other loads, according to the permissible stresses recommended by the subcommittee.

The greater part of the report is devoted to wind-bracing design. A critical comparison is made of the portal method, the cantilever method, and Spurr's method. Exposition of the latter is supported by a carefully worked-out example in the appendix, which should greatly facilitate the application of this method to the actual problems of practice.

Comparison is made of the relative rigidity afforded by welded and riveted connections, and new experimental information is presented on the magnitude of the story drift angle due to the deformation of the connections themselves.

News of Local Sections

CENTRAL ILLINOIS SECTION

The Central Illinois Section held its regular bimonthly meeting at the Inman Hotel in Champaign, Ill., on October 27, with 49 members and guests in attendance. The feature of the occasion was an illustrated address on the subject, "Whisperings from Geology," given by M. M. Leighton, Chief of the Illinois State Geological Survey. This was the annual social meeting of the Section and proved to be a very enjoyable affair.

CENTRAL OHIO SECTION

On October 11 a luncheon meeting of the Central Ohio Section was held in Columbus. Part of the session was devoted to a dis-

EIGHTY-FIRST ANNUAL MEETING, January 17–20, 1934, in New York, N.Y. Complete Program in January Issue.

cussion of various business matters. Then the meeting was turned over to R. T. Regester, chairman of the code committee of the Section, who discussed the development of the proposed Code of Fair Competition for the Professional Engineer Division of the Construction Industry. There were 24 present.

CINCINNATI SECTION

There were 70 in attendance at a meeting of the Cincinnati Section held on October 30. To fill the position of Secretary-Treasurer left vacant by the death of Clifford N. Miller, who had served in that capacity for ten years, William W. Carlton was elected to the office. After a business session, the members enjoyed a talk by F. H. Waring, Chief Engineer of the Ohio State Department of Health, who outlined the problems of stream pollution and sewage disposal in the Ohio River valley, with particular reference to the Cincinnati area. An enthusiastic discussion of this topic followed.

COLORADO SECTION

A meeting of the Colorado Section was held at the Denver Athletic Club on October 16, following a dinner attended by approximately 60 members and guests. The feature of the occasion was an address by F. G. Jonah, Vice-President of the Society and Chief Engineer of the Frisco Lines, who spoke on the change that is taking place in the administration of public affairs in the United States and other countries. An animated discussion from the floor followed Colonel Jonah's talk.

DAYTON SECTION

The Engineers Club was the scene of a luncheon meeting of the Dayton Section held on October 16. After the usual discussion of routine business matters, William J. Aull gave a talk on the subject, "Stamp Collecting as a Hobby."

DETROIT SECTION

At a meeting of the Detroit Section held on October 19, officers for the coming year were elected as follows: Harry A. Shuptrine, President; Martin R. Fisher, First Vice-President; Robert H. Sherlock, Second Vice-President; and W. C. Hirn, Secretary-Treasurer. The section had for guests of honor on this occasion Alonzo J. Hammond, President of the Society, and Henry E. Riggs, Professor of Civil Engineering at the University of Michigan, both of whom gave brief addresses.

ITHACA SECTION

The annual meeting of the Ithaca Section was held in Willard Straight Hall on the campus of Cornell University on October 19. The guest speaker was Dexter S. Kimball, Dean of the College of Engineering at the university, who discussed the topic, "Is Engineering to Be a Closed Profession?" The annual election of officers, which was held at this session, resulted as follows: Edward H. Prentice, President; Hubert E. Snyder, Vice-President; and John E. Perry, Secretary-Treasurer.

KANSAS SECTION

There were 42 in attendance at a meeting of the Kansas State Section, held on October 11. After dinner H. A. Marshall summarized the Code of Fair Competition for the Professional Engineer Division of the Construction Industry, and C. H. Scholer presented the subject of registration of engineers in Kansas.

METROPOLITAN SECTION

The regular monthly meeting of the Metropolitan Section was held on November 15 in the auditorium of the Engineering Societies Building, to consider the subject, "Engineering and the Graphic Arts," presented by James K. Finch, Renwick Professor of Civil Engineering at Columbia University. Explaining the basic processes underlying reproductions by woodcut, engraving, etching, and lithography, Professor Finch illustrated his points by delightful anecdotes and examples of notable prints, mostly historic and engineering in character. After an open discussion refreshments were served. The attendance was about 200.

MILWAUKEE SECTION

Numerous business matters occupied part of the meeting of the Milwaukee Section, held at the City Club on September 21. The president of the Section, E. D. Roberts, addressed the session on the proposed civil engineers' code under the National Recovery Act. An enthusiastic discussion of this topic followed.

NORTHWESTERN SECTION

On October 26 the Northwestern Section sponsored a meeting which was held jointly with local sections of the following national engineering societies: The American Society of Mechanical Engineers, The American Society for Steel Treatment, The American Institute of Mining Engineers, The American Society of Heating and Ventilating Engineers, the University of Minnesota Student Chapter, and the university Student Branch of the American Society of Mechanical Engineers. The principal speakers were William Carey, State Engineer of Minnesota for the Public Works Administration, and Alvin H. Hansen, of the University of Minnesota. Following this program, the annual election of officers was held, with the following results: Walter H. Wheeler, President; H. M. Hill, First Vice-President; O. M. Leland, Second Vice-President; and Lorenz G. Straub, Secretary-Treasurer.

PHILADELPHIA SECTION

The Philadelphia Section's first meeting of the season was held on October 18. There were 52 members and guests present at the dinner and 77 in attendance at the meeting that followed. On behalf of the Philadelphia Technical Service Committee, William C. O'Neill, Jr., spoke on the subject of the necessity of raising funds for the relief of unemployed engineers and chemists during the coming winter. The first scheduled speaker was H. S. R. McCurdy, Chief Engineer of the Philadelphia Suburban Water Company, who gave a description of the dam recently constructed on Crum Creek. The next address was by William C. Wills, Chief Engineer of the Board of Water Commissioners of Wilmington, Del., who discussed the new storage dam built by that city. Ground-water supplies in the Tri-State area of New Jersey were discussed by H. T. Critchlow, Division Engineer of the New Jersey State Water Policy Commission.

PROVIDENCE SECTION

There were 60 members and guests present at a meeting of the Providence Section held on October 13. The annual election of officers resulted as follows: Harold E. Miller, Chairman; Warren G. Baxter, Vice-Chairman; and William R. Benford, Secretary and Treasurer. Following the election, an interesting talk was given by Leslie A. Hoffman, State Engineer of the Public Works Administration for Rhode Island and Connecticut.

SAN FRANCISCO SECTION

A regular meeting of the San Francisco Section was held at the Engineers' Club on August 15, with 110 members and guests in attendance. After a business session, the members had the pleasure of hearing M. E. Lombardi, director of the Standard Oil Company of California, who spoke on the subject, "A California Oil Company on the Persian Gulf."

TACOMA SECTION

At a meeting of the Tacoma Section held on October 4, Joseph Jacobs, consulting engineer of Seattle, addressed the members on the subject of the proposed Grays Harbor Ship Canal. On the occasion of the meeting held on October 18, Mr. Nightingale, Sanitary Engineer of the Department of Health, State of Washington, described the three-million-dollar trunk sewer system that the city of Tacoma may construct.

TEXAS SECTION

The fall meeting of the Texas Section was held in Dallas on October 12 and 13. During this two-day session the following officers were elected for the next year: C. M. Davis, President; J. A. Focht, First Vice-President; W. H. Meier, Second Vice-President; and J. T. L. McNew, Secretary-Treasurer. Numerous interesting papers were presented. Included among the speakers were the following: T. J. Kelly, of the Texas State Highway Department; F. K. Rader, of Southern Methodist University; Col. I Ashburn, chairman of the Texas Public Works Committee; and R. A. Thompson, State Engineer of the Public Works Administration. On the evening of the twelfth, a dinner dance was given to commemorate the twentieth anniversary of the founding of the Section. At this time J. M. Howe, of Houston, acted as spokesman for the charter members present and gave a brief résumé of the history of the Section. At the close of his remarks he was presented with an engraved silver plaque, in recognition of his many services to the Section.

Presented To
Joseph Milton Howe
Past Vice President
A·S·C·E
By The
Texas Section
In Recognition Of Long
Distinguished Service
To The Society
October 12 13
1933

ENGRAVED PLAQUE PRESENTED TO J. M. HOWE, M. AM. SOC. C.E., AT THE FALL MEETING OF THE TEXAS SECTION

Student Chapter News

ANTIOCH COLLEGE

Semi-monthly meetings of the Antioch College Student Chapter were held last year. These gatherings were addressed by faculty and outside speakers, including Arthur E. Morgan, president of the college, and C. S. Rhindsfoos, vice-president of the Brunson Trust Company, of Columbus, Ohio. One session of particular interest was devoted to a consideration of the engineering aspects of the Century of Progress Exposition.

CARNEGIE INSTITUTE OF TECHNOLOGY

The Carnegie Institute of Technology Student Chapter reported 100 per cent enrollment of those eligible for membership during the school year 1932–1933. It held 31 meetings, with a total attendance of 1,960. Among the outside speakers who addressed the meetings were the following: R. W. Remp, superintendent of the Dravo Contracting Company; George W. Thomas, Chief Engineer of the H. H. Robertson Company; E. E. Bankson, member of the firm of the J. N. Chester Engineers; and W. R. Triem, superintendent of freight transportation for the Pennsylvania Railroad.

MICHIGAN STATE COLLEGE

During the past school year the Michigan State College Student Chapter held 31 meetings, with a total attendance of 879. Numerous papers on a wide range of engineering subjects were presented on these occasions by students in a senior seminar. Some meetings were addressed by members of the faculty and by outside speakers.

MONTANA STATE COLLEGE

Illustrated lectures furnished by the Society were featured at several of the meetings of the Montana State College Student Chapter held during the past year. Members of the faculty and of the Chapter spoke at other meetings on timely engineering topics. The enrollment of those eligible for membership in the Chapter was 100 per cent.

NEW MEXICO STATE COLLEGE

The New Mexico State College Student Chapter, organized during the school year 1932–1933, reports that several interesting meetings were held. Other activities included an engineering exhibition, given on St. Patrick's Day, to which the public was invited, and an engineers' ball, one of the outstanding social events of the season.

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING

In spite of the depression, the North Carolina State College of Agriculture and Engineering Student Chapter reports that membership in the Chapter dropped but slightly during the past school year. The chapter was active in organizing the annual Engineers' Fair sponsored by the engineering students of the college. At one of the meetings held during the year, C. L. Garner, Assistant Chief of the Division of Geodesy of the U. S. Coast and Geodetic Survey, was guest speaker.

RHODE ISLAND STATE COLLEGE

On October 23, 1933, the Rhode Island State College Student Chapter held a meeting that was attended by 21 students and 2 members of the faculty. The feature of the occasion was an interesting illustrated lecture given by Irwin Sapadin, of the class of 1934. An animated discussion followed this presentation.

STATE COLLEGE OF WASHINGTON

The programs presented by the State College of Washington Student Chapter during the past year were interesting and varied. Motion pictures, shown through the courtesy of the Hanna Engineering Company and the U. S. Army Engineers, were enjoyed, as were several illustrated lectures loaned by the Society. Other meetings were addressed by members of the faculty and the Student Chapter and by outside speakers.

UNIVERSITY OF COLORADO

The University of Colorado Student Chapter held 15 meetings during the past year, with a total attendance of 546. On November 2, Herbert S. Crocker, then President of the Society, spoke on "Ideals of Engineering." Other interesting meetings were devoted to student lectures and to the showing of lantern-slide lectures furnished by the Society.

UNIVERSITY OF NEW HAMPSHIRE

Members of the University of New Hampshire Student Chapter enjoyed numerous interesting meetings during the past year. Upon these occasions a total of 80 papers was presented by the students. In addition, there were two special meetings at which outside speakers were heard.

UNIVERSITY OF MAINE

The University of Maine Student Chapter reports that keen interest in the Chapter was maintained during the school year 1932–1933. In all, there were seven meetings, with a total attendance of 260. Many sophomores and freshmen attended these sessions, and the faculty was also well represented.

UNIVERSITY OF MICHIGAN

Frequent and interesting meetings were held by the University of Michigan Student Chapter during the school year 1932–1933. Members of the faculty were well represented on the list of speakers for these occasions. At the meeting held on December 15, Herbert S. Crocker, then President of the Society, gave a talk, and on another occasion S. C. Hollister, Professor of Structural Engineering at Purdue University, was guest speaker.

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for January

VARIED ARTICLES of wide interest from scattered points of the compass will comprise the January issue, the first number of the fourth volume of CIVIL ENGINEERING. They include a description of the engineering and construction features of the two recently completed tunnels under the Scheldt River at Antwerp, Holland, and that of a fine example of cooperation between geologist and engineer on a New England power development.

In addition, members will look forward to the publication in the January number of the complete program of the Annual Meeting of the Society, to be held in New York, N.Y., January 17–20, 1934.

Vicksburg Laboratory

IN EFFORTS to determine the action of water in motion, countless experiments have been made. Leonardo da Vinci once said, "When you try to explain the behavior of flowing water remember to demonstrate the experiment first and the cause next."

For the practical study of river hydraulics, the Government has placed in operation a laboratory at Vicksburg, Miss. The building and its outdoor facilities for conducting tests on models of rivers, as seen from the air, are impressively shown on the Page of Special Interest in this issue. It will be helpful to study this aerial photograph in connection with the paper in the November number of PROCEEDINGS, by H. D. Vogel, Assoc. M. Am. Soc. C.E., on "Practical River Laboratory Hydraulics.

Water for the experiments is provided by a dam about $4^{1}/_{2}$ miles below Vicksburg on a small tributary of the Mississippi River. This structure is 19 ft high and 400 ft long. The reservoir has a capacity of 200 acre-ft and covers 40 of the 140 acres in the tract purchased by the Government for the experiment station. The laboratory has been in operation since January 1, 1931, for the solution of problems referred to it by the President of the Mississippi River Commission. Besides the executive and engineering personnel of the laboratory, about 40 assistants and helpers aid in conducting the experiments.

In the aerial photograph are shown the main features of the laboratory, including the dam and one corner of the reservoir; the administration building, which also houses the interier testing apparatus; and many of the models for the study of separate problems of the river, which are set up in the open below the dam.

The Electron Theory of Air Currents and Rainfall

By HALBERT P. GILLETTE

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
EDITOR, "ROADS AND STREETS," CHICAGO, ILL.

THE PART THAT the electron plays in causing weather disturbances is that of a star actor and not that of a supernumerary. It has long been known that electrons act as nuclei of drops and droplets of moisture, and therefore that their presence in large numbers must be conducive to rainfall. However, meteorologists have argued that dust particles also act as such nuclei, and since there is always an abundance of these particles in the air, the aid of the electron in causing rain is not needed. The electron, however, possesses a property not possessed by the particle of dust, namely, that it is automotive. Unlike the dust particle, it is not dependent upon air currents. In fact, it has the power to cause air currents, since a current of electrons carries air molecules with it.

It is now fully established that there are two shells of electrons encasing the earth, and there is evidence of several more shells. One of these two shells, which is called the Kennelly-Heaviside layer, is about 60 miles above the earth. The other, which is about twice as high, is called the Appleton layer. Both act as reflectors of radio waves and make long-distance broadcasting possible. By study of radio waves it has been found that these electron shells are higher above the earth at night than in the daytime.

Since the earth's surface is charged with electrons, it follows that if the elevation of an electron shell increases, there will be less electric pressure in the air between the shell and the earth, and electrons will tend to flow from the earth into the air. A converse electron flow tends to occur in the daytime, so there should be a 24-hr cycle of upward electron currents due to the dirunal movement of the electron shells. This should tend to cause rainfall at night, with a maximum shortly after midnight. This is exactly what occurs over the ocean, but over land the converse is the case. Hence if the electron theory of rainfall is correct, there must be some cause of a maximum upward current of electrons over land, which operates to a less degree over water. This cause is the liberation of electrons from atoms as the temperature rises.

A daily change of 2 deg in the temperature of ocean water is a great change, whereas a daily change of 60 deg in the surface of the ground is common, and at times there is a much greater change. So on the afternoon of a summer day, electrons escape from the ground at a maximum rate, in spite of the fact that the electron shells are then lowest. As the electrons ascend they tend to travel in a counter-clockwise spiral in the northern hemisphere, acting according to the principle of magnetic rotation of electric currents. Faraday discovered that principle about a century ago, or nearly 60 years before the electron was discovered. The result of this spiral rotation of ascending electrons is cyclonic rotation of the air, with an accompanying fall of the barometer. Since the ascending electrons carry moisture with them, the condensation of that moisture in the cooler upper air tends to cause rainfall.

ORIGIN OF TROPICAL HURRICANES

Water is a fairly good conductor of electrons, whereas dry land is a poor conductor, which explains why tropical hurricanes are ocean-born, are great in magnitude, and are most frequent in the late summer. They usually originate when the ocean is hottest, and is therefore emitting electrons most freely. When an ascending whirl of electrons is formed, it must be maintained by a rapid flow of electrons into it. Being a good conductor, the ocean supplies the flow from below to an extent that would be impossible if the whirl were over the land. This electron flow permits the occasional building up of a whirl of vast diameter and of great violence. Since nearby electrons in such a whirl are moving in the same direction, they attract one another magnetically with a force that increases with their velocity. But the opposite sides of such a whirl repel one another both magnetically and electrically, thus tending to expand the whirl. It would soon disrupt itself were the electrons not also ascending and attracting one another magnetically because of a common vertical movement. The infrequency of tropical hurricanes indicates that, in addition to the conditions just given, there must exist an unusually great uplift of the electron shells with its concurrent upward flow of electrons.

Over a heated land mass, where winds from a tropical ocean bring electrons

EIGHTY-FIRST ANNUAL MEETING, January 17–20, 1934, in New York, N.Y. **Complete Program in January Issue.**

n abundance, tornadoes tend to develop n a manner similar to the development f tropical hurricanes. But the tornado s necessarily much smaller and shorter-ived, for it is fed with electrons from the ground, which is a poor conductor. On the other hand, local concentrations of electrons occur in the ground surface when the temperature is very high and the ground is consequently dry. Incidentally, this explains a phenomenon to which Dr. Charles F. Brooks has called attention, namely, the tendency of thunderstorms to start over dry ground rather than over ground that has been wet by the rains of a day or so before.

About two years ago, John Cage produced a miniature "water spout" in a metal basin full of California crude petroleum, by connecting the basin with a negative pole of an influence machine and holding over the petroleum a 4-in. metal ball connected with the other pole. The electrons leaked across the space and imparted upward spiral rotation to the petroleum, so that a petroleum "water spout" about 1 in. in diameter and 4 in. high was produced.

Experiments with the effects of cyclonic and anticyclonic air whirls on radio reception have been made by Prof. R. C. Colwell, of West Virginia University. As a result of these experiments he has come to the conclusion that electrons are ascending in a cyclone and descending in an anticyclone.

There is abundant evidence that terrestrial electron shells are periodically displaced eccentrically and are, also, periodically warped by magnetic forces. If the sun and moon have rotating electron shells, it becomes easy to explain the semi-solar day and semi-lunar day disturbances of the magnetic needle. Also, this would explain why the earth's shells are pushed earthward by both the sun and moon when they are overhead, as shown by radio wave experiments. This displacement of electron shells has been attributed to streams of electrons from sun and moon. While the theory of a solar stream is plausible, that of a lunar stream is not, and neither stream is necessary, for rotating electron shells around the sun and the moon would repel rotating terrestrial shells both magnetically and electrically. These movements of the terrestrial shells act like the opening of valves, for they cause the electron currents previously described.

Electron vs. Heat-Convection Theory

Very few meteorologists are acquainted with the electron theory, yet nearly all are very skeptical of the theory of an electron cause of air currents. Such skepticism arises, not because of known limitations of the electron theory but from belief in the adequacy of the heat-convection theory. However, study of many papers on air whirls shows diversity of opinion among meteorologists as to their cause. Other diversities of opinion on important weather phenomena indicate that meteorology is still an infant science. The inability to forecast weather satisfactorily more than a few days in advance proves how little is known about it. It is surprising, therefore, to find so little attention given by meteorologists to one of the most promising fields in the investigation of weather, namely, the effect of the electron upon air currents and rainfall.

Welding the West's Largest Pipe Line

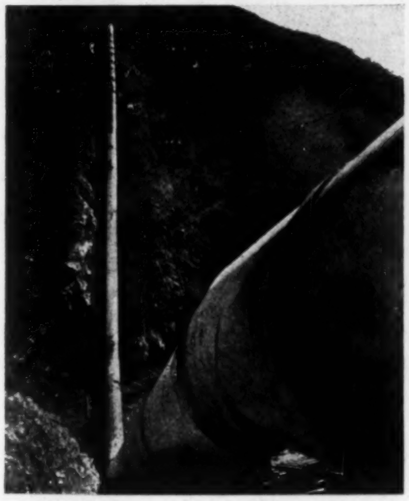
Crossing canyons and straddling mountains, a $4^1/_2$-mile pipe line will soon join the new Bouquet Canyon Reservoir with the Owens Valley Aqueduct, near Saugus, Calif. The line will form a part of the system of the Department of Water and Power, City of Los Angeles.

Said to be the largest in the West, the pipe line varies in diameter from 80 to 94 in. The 80-in. pipe, used where the pressure is the greatest, is $1^1/_{16}$ in. thick. At the bottom of one of the canyons crossed, the pressure is equal to 400 lb per sq in. As shown in the accompanying photographs, the country traversed by the line is extremely rough and has unbelievably steep grades.

Sections of the pipe weighing approximately 12 tons each are hauled by trucks to the job, where the Department of Water and Power of the City of Los Angeles has a sand-blasting and painting plant which cleans and paints the pipe. It is then hauled on trucks to the top of the mountains and lowered by a hoist down the canyon sides with carriers, called "straddle bugs," designed for handling this pipe.

An idea of the size of the pipe may be gained from the fact that it takes 450 lb of electrodes to weld each joint on the job. Thirty-two man-hours are required to weld the outside of each joint, and 24 man-hours for the inside. The welding is being carried on 24 hr a day in three 8-hr shifts.

Laying of the line and field welding are done by the Los Angeles Department of Water and Power, of which H. A. Van Norman, M. Am. Soc. C.E., is chief engineer. Photographs and welding data are furnished by courtesy of the Lincoln Electric Company.



Pipe Line for Los Angeles Supply

7-Ft Diameter Water Pipe from Bouquet Canyon Reservoir to the Owens Valley Acqueduct, near Saugus, Calif.

Fabrication and Erection by Welding

450 Lb of Electrodes and 56 Man-Hours of Labor Required for Each Joint of This Pipe Line

NEWS OF ENGINEERS

From Correspondence and Society Files

A. J. Sutton Pippard, who was formerly Professor of Civil Engineering at the University of Bristol, in Bristol, England, has received a similar appointment in the Imperial College of Science and Technology of the University of London.

Clarence A. Walkwitz has accepted a position as superintendent of construction in the Quartermaster Corps of the U.S. War Department, with headquarters at Fort Riley, Kans.

Edward M. Markham has received the appointment of Chief Engineer of the U.S. War Department with the rank of major-general. He was formerly colonel of the Corps of Engineers of the U.S. Army and Division Engineer of the Great Lakes Division of the War Department.

C. L. Huff has been made General Manager and Chief Engineer of the Hidalgo and Cameron Counties Water Control and Improvement District No. 9, with headquarters in Mercedes, Tex.

F. E. Trask is now California State Engineer for the Federal Emergency Administration of Public Works, with headquarters in Los Angeles.

Ronald M. Wilson, formerly a topographic engineer with the U.S. Geological Survey, has recently been promoted to the position of Chief of the Section of Computing of the Survey.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From October 10 to November 9, 1933, Inclusive

Additions to Membership

Andrew, Robert Morrison (Jun. '33), 611 North Pennsylvania St., Apartment 2, Indianapolis, Ind.

Barber, Carlton McCrary (Assoc. M. '33), Res. Engr., State Highway Comm., Box 1691, Wichita, Kans.

Bates, William Howard (Jun. '33), With Tennessee Valley Authority (Res., 404 East Ash St.), La Follette, Tenn.

Belaeff, Nicholas Platon (Jun. '33), 511 West 113th St., New York, N.Y.

Blaisdell, Fred William (Jun. '33), 58 Trowbridge St., Cambridge, Mass.

Blakeman, Herbert Edward (Jun. '33), 268 Saratoga Ave., Brooklyn, N.Y.

Branch, William Martin (Jun. '33), 334 Walker St., Augusta, Ga.

Brightman, Edwin (Jun. '33), 852 Ackerman Ave., Syracuse, N.Y.

Burko, William (Jun. '33), 96 East 7th St., New York, N.Y.

Capling Leonard (Jun. '33), 905 South 10th Ave., Maywood, Ill.

Carbone, Bartholomew Leon (Jun. '33), 75 Bay Ridge Ave., Brooklyn, N.Y.

Comins, Harrison Durgin (Jun. '33), Taylor Hall-D, Lehigh Univ., Bethlehem, Pa.

Darling, Horace Velpeau (Jun. '33), Associate Engr., Board of Engrs. for Rivers and Harbors, U.S. Govt. (Res., 250 Farragut St., N.W., Apartment 102), Washington, D.C.

Davison, Milbern Harry (Jun. '33), Engr., Min. Dept., Central Coal & Coke Co., 9th and Walnut Sts., Kansas City, Mo. (Res., 1334 Quindaro, Kansas City, Kans.)

Ehasz, Francis Louis (Jun. '33), Eötvös Collegium, Nagyboldogasszony-ut 18, Budapest I, Hungary.

Elliot, Donald George (Jun., '33), Designer, Monsarrat & Pratley, 909 Drummond Bldg., Montreal, Que., Canada.

Ellis, Gene (Jun. '33), 1273 Van Buren, Topeka, Kans.

Griffiths, John David (Jun. '33), 6961 Maple St., Takoma Park, D.C.

Grover, LaMotte (Assoc. M. '33), Bridge Engr., Dept. of Design, State Highway Comm. (Res., 1255 Collins), Topeka, Kans.

Haynes, Wesley Eaton (Jun. '33), Junior Engr. and Draftsman, State Highway Dept., 1 Cummings Ave., Concord, N.H.

Herman, Bruce Alfred (Jun. '33), 4409 Belvieu Ave., Baltimore, Md.

Holzman, John (Jun. '33), 1678 Union St., Brooklyn, N.Y.

Huber, Levi Albertson (Jun. '33), 297 East Commerce St., Bridgeton, N.J.

Irwin, Fredrick Bruce (Jun. '33), 607 South Sandusky Ave., Upper Sandusky, Ohio.

Jayne, Stephen Cornelius (Jun. '33), Res. Engr., State Dept. of Highways, Box 430, Wenatchee, Wash.

Jenkins, John Joseph, Jr. (Jun. '33), Gilman Apartments, C-4, Calvert and 31st Sts., Baltimore, Md.

Johnson, John William (Jun. '33), 3449 Finlaw Ave., Pensauken, N.J.

Kindinger, Martin (Assoc. M. '33), Res. Engr., Bridge Constr., Divisional Council of Somerset East; 41, Western Rd., Port Elizabeth, C.P., Union of South Africa.

Kline, Arthur (Assoc. M. '33), Div. Engr., Met. Dist. Water Bureau, Hartford County, Barkhamsted, Conn.

Liccione, Daniel Joseph (Jun. '33), 196 Spring St., New York, N.Y.

McComb, Fred Robert (Jun. '33), 433 North Terrace Drive, Wichita, Kans.

Marsh, Edward Theodore (Jun. '33), 5818 Carpenter St., Philadelphia, Pa.

Meyer, John Gavin (Assoc. M. '33), Associate Highway Engr., State Div. of Highways, 262 South Auburn St., Grass Valley, Calif.

Mohl, Emanuel Israel (Jun. '33), 12 Rochelle Ave., Rochelle Park, N.J.

Moore, Francis Cochrane (Jun. '33), 10 Allen St., Amherst, Mass.

Morris, John Hite (Jun. '33), 244 Grand St., Morgantown, W.Va.

Neider, Russel Charles (Jun. '33), 10 James St., Hillside, N.J.

O'Donnell, William Joseph (Jun. '33), The Catholic Univ. of America, Box 411, Washington, D.C.

Palmieri, Mario (Assoc. M. '33), Asst. Bridge Designing Engr., Bridge Dept., State Div. of Highways (Res., 900 McClatchy Way), Sacramento, Calif.

Parker, Antoine Panet (Jun. '33), 214–30 Twenty-seventh Ave., Bayside, N.Y.

Parsons, Norman Welbec (Jun. '33), 1239 College Ave., Morgantown, W.Va.

Perricelli, Ernando Frank (Jun. '33), 873 East 181st St., New York, N.Y.

Petitmermet, Paul Jules (Jun. '33), 300 Commonwealth Ave., Newton, Mass.

Poorman, Mary Esther (Jun. '33), 329 Russell St., West Lafayette, Ind.

Rantz, Saul Edward (Jun. '33), 2603 South Fairhill St., Philadelphia, Pa.

Reed, Garner Wade (Jun. '33), 128 Willow St., Brooklyn, N.Y.

St. Clair, William Thaddeus (Assoc. M. '33), 1705 Cedar Lane, Nashville, Tenn.

Schnackenberg, Ellis Carl (Jun. '33), Care, Public Works Dept., Greymouth, New Zealand.

Schucker, George Wayne (Jun. '33), 1101 North Bentalou St., Baltimore, Md.

Siebert, Henry Edward (Jun. '33), 137 Senator St., Brooklyn, N.Y.

Simpson, George Elliott (Jun. '33), Darien, Conn.

Stoliaroff, Nicholas Serge (Jun. '33), 2159 Morris Ave., New York, N.Y.

Thompson, Paul Williams (Jun. '33), Corps of Engrs., U.S.A., U.S. Engr. Office, 707 Postal Telegraph Bldg., Kansas City, Mo.

Wellner, John Arnold (Jun. '33), 511 North Harlem Ave., Oak Park, Ill.

Whitney, Lawrence Woodward (Jun. '33), 45 Sterling St., Brooklyn, N.Y.

Wilkens, Werner, Jr. (Assoc. M. '33), Care, The Armco International Corporation, Middletown, Ohio.

Wilson, Carl Amos (Jun. '33), Asst. to County Engr., Wyandotte County (Res., 904 Armstrong Ave.), Kansas City, Kans.

Membership Transfers

Adams, William Neil (Assoc. M. '23; M. '33), Chf. Bridge Designer, State Highway Comm. (Res., 711 Hodge Ave.), Ames, Iowa.

Aull, Luther Bachman, Jr. (Jun. '25; Assoc. M. '33), Res. Engr., State Highway Dept., Box 368, Union, S.C.

Booth, Archibald Allan Kirschner (Jun. '27; Assoc. M. '33), Newfield, N.Y.

Cleland, Ralph Rankin (Jun. '29; Assoc. M. '33), San. Engr., Pennsylvania State Coll. (Res., 306 Miles St.), State College, Pa.

Crites, George Solomon (Assoc. M. '15; M. '33), Div. Engr., B. &. O. R.R., 313 Highland Ave., Punxsutawney, Pa.

Dunham, John Wetherbee (Jun. '23; Assoc. M. '29; M. '33), Senior Structural Engr., Office of Superv. Archt., U.S. Treasury Dept. (Res., 803 Quintana Pl., N.W.), Washington, D.C.

Hannigan, Edward John (Jun. '32; Assoc. M. '33), 2932 1/2 Ninth Ave., Los Angeles, Calif.

Ivanchenko, Andrei Ivanovich (Assoc. M. '27; M. '33), Civ. Engr.; Asst. Prof. of Hydraulics, North Caucasus Power Inst., Novocherkassk (Res., 3-A Sredny Pereoulok, Novocherkassk-Don), Union of Socialistic Soviet Republics.

Jung, Werner Fred (Jun. '28; Assoc. M. '33), 10523 Hathaway Ave., Cleveland, Ohio.

Lindsay, William Steen, Jr. (Jun. '20; Assoc. M. '26; M. '33), Engr., J. E. Sirrine & Co., Box 1221, Greenville, S.C.

Male, Milton (Jun. '29; Assoc. M. '33), Technical Asst., U.S. Steel Corporation, 71 Broadway, Room 1309 (Res., 444 Central Park West), New York, N.Y.

Moffett, John William (Assoc. M. '17; M. '33), Chf. Structural Engr., United Engrs. and Constructors, Inc., 1401 Arch St. (Res., 1037 Chelton Ave., Oak Lane), Philadelphia, Pa.

Morris, Earle Hedderich (Assoc. M. '22; M. '33), Chf. Engr., Public Service Comm. of West Virginia, Box 1231, Charleston, W.Va.

Pittman, Everette Edward (Assoc. M. '29; M. '33), Res. Engr., State Highway Dept., 1209 Norwood Bldg. (Res., 2821 Salado St.), Austin, Tex.

Reed, Percy Lawrence (Assoc. M. '17; M. '33), Prof., Civ. Eng. and Head of Dept., Coll. of Eng., Univ. of Florida, Box 643, Gainesville, Fla.

Santos, Tirso Nollora, Jr. (Jun. '28; Assoc. M. '33), Asst. Structural Engr., Office of Superv. Archt., Treasury Dept., Washington, D.C.

Thompson, Sophus (Jun. '29; Assoc. M. '32), Head, Civ. Eng. Dept., Southern Methodist Univ., Dallas, Tex.

Stearns, John (Assoc. M. '15; M. '33), Div. Engr., Div. 3, Met. Water Dist. of Southern California, Banning, Calif.

Reinstatements

Kelly, Paul Augustine, Assoc. M., reinstated Oct. 17, 1933.

Mitchell, Adolphus, Jun., reinstated Nov. 8, 1933.

Resignations

Alton, Donald Robb, Jun., resigned Nov. 1, 1933.

Betzer, Stanley Irvin, Jun., resigned Oct. 24, 1933.

Engstrom, Clifford Godfred, Jun., resigned October 17, 1933.

Greubel, Wilfred George, Jun., resigned Nov. 8, 1933.

Petrillo, William Santo, Jun., resigned Nov. 1, 1933.

Phillips, Preson Peek, M., resigned Nov. 1, 1933.

Siler, Roy Brown, Assoc. M., resigned Oct. 25, 1933.

Taylor, Bill Northcutt, Assoc. M., resigned Oct. 23, 1933.

Waite, Guy Bennett, Jr., Assoc. M., resigned Oct. 19, 1933.

Wonning, Harvey Henry, Assoc. M., resigned Oct. 24, 1933.

Waterbury, Clarence Leslie, Jun., resigned Nov. 6, 1933.

Allman, Sydney Kayser, Jr., Jun., resigned Oct. 19, 1933.

Deaths

Smith, Jonas Waldo. Elected Assoc. M., October 5, 1892; M., April 5, 1899; Hon. M., October 1, 1928; died October 14, 1933.

Conn, Charles Francis. Elected M., October 7, 1914; died October 19, 1933.

Dillman, Daniel Walter. Elected Assoc. M., May 28, 1923; died October 31, 1933.

Leland, Warren Allston. Elected M., October 3, 1900; died August 28, 1933.

Luther, Herbert Lawrence. Elected Assoc. M., May 31, 1916; died September 23, 1933.

Lyle, William Thomas. Elected Assoc. M., November 6, 1901; M., October 12, 1925; died October 31, 1933.

Mead, John. Elected M., December 3, 1912; date of death unknown.

Meserve, Frank Pierce, Jr. Elected Jun., October 1, 1928; died July 14, 1933.

Miller, Clifford Neville. Elected Jun., June 4, 1891; Assoc. M., February 5, 1896; died October 23, 1933.

Reidpath, Robert John. Elected M., April 2, 1912; died July 14, 1933.

Rey, Richard Franklin. Elected Assoc. M., October 26, 1931; died October 7, 1933.

Ricker, George Alfred. Elected Jun., April 7, 1886; Assoc. M., May 1, 1895; M., April 3, 1901; died November 2, 1933.

Schnabel, William Charles. Elected Assoc. M., November 25, 1919; M., May 28, 1923; date of death unknown.

Sherrerd, Morris Robeson. Elected Assoc. M., May 3, 1893; M., May 6, 1896; died October 19, 1933.

Skelton, Ray Hamilton. Elected M., May 25, 1931; died October 29, 1933.

Stone, Solon Jones. Elected M., November 27, 1917; died November 5, 1933.

Thayer, Russell. Elected M., December 6, 1882; died October 21, 1933.

Wheeler, Harry Roberts. Elected Jun., April 4, 1888; Assoc. M., May 4, 1892; M., March 1, 1910; died October 29, 1933.

Windrow, Rollen Joe. Elected Assoc. M., September 2, 1914; M., April 21, 1920; died October 30, 1933.

TOTAL MEMBERSHIP AS OF NOVEMBER 9, 1933

Members	5,769
Associate Members	6,275
Corporate Members	12,044
Honorary Members	18
Juniors	2,918
Affiliates	112
Fellows	5
Total	15,097

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 97 of the 1933 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York office, unless the word Chicago or San Francisco follows the key number, when the reply should be sent to the office designated.

Design

Civil Engineer; Assoc. M. Am. Soc. C.E.; 30; single; graduate; licensed; 12 years experience in structural design, drafting, and surveying; design of steel and concrete railroad tunnel structures; indeterminate analysis; alignments. Checker on construction drawings; 7 years charge of work; 2 years park and highway surveying. Translate technical German. D-2630.

Structural Designer; Assoc. M. Am. Soc. C.E.; 31; licensed, New York State; graduate of Rensselaer Polytechnic Institute; 10 years intensive practice; design, specifications, estimates, and reports; 8 years consulting engineer on bridges and structural design of buildings. Recently associated on design of large vertical-lift bridge. Desires contact, consulting engineer, architect, contractor, or structural fabricator. Available short notice. D-506.

Structural Engineer; Assoc. M. Am. Soc. C.E.; 38; married; graduate; state licenses; 10 years experience, surveying, design, and construction. Design, detail, and preparation of plans and specifications, on railroad, highway, parkway, harbor, and tall building structures. Completely familar with the design of rigid-frame bridges. Available immediately. D-1496.

Executive

Contractors' Engineer and Estimator; Assoc. M. Am. Soc. C.E.; 40; single; Michigan registration; design of reinforced concrete and forms, plant design, construction supervision. Recent successful estimating and close cost analysis of Government buildings, Washington. D-2589.

Executive, Engineer Manager; M. Am. Soc. C.E.; 47; married; licensed in Pennsylvania. Experienced, directing construction bridges, foundations, sewerage, water facilities, etc. Several years making up competitive bids on public and commercial projects, coordinating and expediting subcontracts, sales promotion, and development of mechanical ideas; 14 years chief construction executive, two large organizations. Location East. D-2285.

Engineer; Assoc. M. Am. Soc. C.E.; licensed, New York State; 12 years experience, direct charge construction work, surveys, office work on highways, and bridges; 8 years charge of office, preparing contract plans, writing specifications, and estimating for parks and parkways on major parkway project; 4 years assistant in testing laboratory. Location immaterial. Excellent references. Available immediately. D-2635.

Civil Engineer; M. Am. Soc. C.E.; 20 years experience with large railroad companies and other organizations covering consolidation of lines with other railroads; extensive line-improvement projects; construction, maintenance, yard design, estimating, drafting, research, and surveys. Continuously employed until recent times. Will accept moderate salary. B-9037.

Executive Engineer; Assoc. M. Am. Soc. C.E.; seeks connection with financial house or engineering concern doing domestic or foreign business. C-9867.

Executive; Jun. Am. Soc. C.E.; licensed professional engineer; member of New York Bar; graduate of Manhattan and of Fordham Law School; age 28. Experience: instructor in engineering at Manhattan College; design and valuation, New York Central Terminal; valuation and estimating with architect; practice of law, real estate, and contractor's liens. Situation desired with executive department. C-3265.

Executive; Assoc. M. Am. Soc. C.E.; civil engineer; 34; registered professional engineer; graduate of University of Pennsylvania; 10 years experience. Sales organization and promotion. Consultation, planning, and construction of industrial buildings. Protestant. Married. Speaks Spanish. Available now. C-3604.

Sanitary Engineer; Assoc. M. Am. Soc. C.E.; expert on stream pollution, sewage, and industrial wastes disposal; 10 years experience with largest disposal project in the United States, also sales promotion and reports on new developments with private corporation, qualified to investigate, study, report, design, operate, or take charge. D-1161.

Engineer; Assoc. M. Am. Soc. C.E.; technical education; 20 years experience; licensed New York; certificate National Bureau of Engineering Registration. Design, construction, maintenance, executive, sales. Power and industrial plants, steel structures, railroad and contractor's equipment, conveying and storage plants. B-4537.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 32; professional engineer, licensed New York State; C.E. and B.S. degrees; 10 years varied experience in construction on New York City subway work. Will consider any position connected with engineering. B-7933.

Engineer; M. Am. Soc, C.E.; 25 years experience, direct charge and supervision of construction of railways, bridges, buildings, and other structures, including surveys, in the United States and foreign countries, costing over one hundred million dollars. Expert on concrete, foundations, winter construction, and investigations. Fluent knowledge of French. Excellent references. Available anywhere. B-1476.

Municipal and Sanitary Engineer; Jun. Am. Soc. C.E.; 31; married; 2 years assistant city engineer; 2 years large consulting firm, designing and supervising construction of water works, sewers, and sewage treatment plants; 2 years engineering accountant. Graduate of Michigan University; M.S. degree, municipal and sanitary engineering; licensed two states. Location immaterial. D-700.

Structural Engineer; Assoc. M. Am. Soc. C.E.; 34; graduate of Oregon State College in 1926; B.S. in C.E.; 8 years of design and drafting of steel framing, reinforced-concrete, and timber structures; design and construction of cellulose plants. Any professional work will be accepted. Will go abroad. Speaks Russian. Available now. D-119.

Civil Engineer; M. Am. Soc. C.E.; graduate of Delft University, Holland; 49; licensed New York; 9 years in responsible charge of construction of tunnels and bridges; 3 years railroad maintenance, track work, and design; 5 years as inspector on 300 railroad structures; 10 years in responsible charge of material testing and inspection for 500-million-dollar construction projects. D-2255.

Junior

Editor-Publisher; Jun. Am. Soc. C.E.; 9 years a magazine editor; 4 years a publisher of engineering and scientific text and reference books; author of 600-page mathematics handbook. C-3432.

Civil Engineer, Jr.; M. Am. Soc. C.E., 25; married; B.S. C.E. 1930, University of Michigan; postgraduate work in hydraulic engineering, 1932–1933; 1 year in Michigan State Highway Department on road construction; as inspector, rodman, instrumentman; 2 years telephone construction engineering. Desires work in any branch of civil engineering. Available immediately. Location immaterial. D-1332.

Engineer; Assoc. M. Am. Soc. C.E.; 33; married; 6 years experience, field and office work on general surveys and construction work, including subaqueous foundations; also 7 years experience as engineer and assistant superintendent at large limestone quarry. Location immaterial. D-2616.

Civil Engineer; Jun. Am. Soc. C.E.; healthy; single, 26; responsible; honor graduate; mathematician; estimator; comptometrist; competent draftsman; civil service rating as sanitary, bridge, and highway engineer; teaching experience; contract construction; 1 year with telephone company; 3 years design, survey, drafting, and construction, New Jersey State Highways. Desires teaching, fellowship, or engineering work. C-7279.

Civil Engineer; Jun. Am. Soc. C.E.; 25; single; Pi Delta Epsilon; Sigma Delta Chi; B.S. hydro-electric engineering, University of California, 1931; 2 years editorial experience, college technical publication; 1 year field experience, land and hydrographic surveying. Knowledge Spanish. Desires experience, civil, hydraulic or electrical engineering, technical journalism, preparation of reports. D-2628-3310-A-6-San Francisco.

Civil Engineer; Jun. Am. Soc. C.E.; 29; B.C.E. from Louisiana State University; Louisiana state licensed; 10 years experience, field and office work, in engineering department of Southern Pacific Railroad and construction department of Louisiana Highway Commission. Good draftsman. Available now. Location anywhere. D-2277.

Assistant Civil Engineer; Jun. Am. Soc. C.E.; 24; single; B.C. and C.E.; 2 years assistant engineer, field and office investigation, survey and preliminary design for flood-control and water-supply projects; 2 years private surveys, computations, and construction; 3 months, state highway; 2 years instructor in evening college. Good references. Working or teaching position. D-2248.

Civil Engineer; Jun. Am. Soc. C.E.; Cornell University, C.E.; 26; single; 5 years with general contractor as field engineer and assistant-superintendent in charge of subway, sewer, pipe, and utility lines, building construction. Good office man on estimates, design, drafting. Best references. Location anywhere. Salary open. C-6070.

Civil Engineer; Jun. Am. Soc. C.E.; B.S. in C.E., Manhattan College, 1932; little experience in field during summer vacation. Location immaterial. Available immediately. D-2310.

Civil Engineer; Jun. Am. Soc. C.E.; 25; single; B.S.C.E. degree, Purdue University, 1930, with highest honors; 3½ years experience on structural steel shop fabrication; design, detailing, field erection, and timekeeping for large structural steel fabricator. Good mathematician, ambitious, reliable. References furnished. Location immaterial. Desires position with reputable construction firm or consulting engineer. D-2655.

Engineer; Jun. Am. Soc. C.E.; 24; single; B.C.E., Brooklyn Polytechnic Institute, 1932. Competent mathematician, draftsman; licensed land surveyor, N.Y.; 8 years office and field experience: city, farm, title, topogrophical, private geodetic surveys; street, sewer locations; tenement-house and office-building construction. Desires permanent connection, any form civil engineering, surveying, bridge design, etc. Location immaterial. D-2661.

Sales

Sales Engineer; Assoc. M. Am. Soc. C.E.; graduate; 39; married; 10 years design of reinforced-concrete and steel structures; 5 years sales and promotion for manufacturer of building products. Have wide acquaintance with architects and general contractors in metropolitan area and New England. Seek connection with manufacturer of building materials. A-5435.

Structural Sales Engineer; M. Am. Soc. C.E.; 45; married. Actively engaged in engineering and sales of fabricating business for over twenty years. Also several years as district representative, western Pennsylvania and Ohio. Very successful record. Available immediately. C-5095.

Business Getter; Assoc. M. Am. Soc. C.E.; having persuasive contacts with a particular class of colleges, schools, and hospitals is open for engagement by large firm having a meritorious product. Commission with drawing account. B-9276.

RECENT BOOKS

New books of interest to Civil Engineers, donated by the publishers to the Engineering Societies Library or to the Society's Reading Room, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 87 of the Year Book for 1933. These notes regarding the books are taken from the books themselves, and this Society is not responsible for them.

Abwasserfachgruppe der Deutschen Gesellschaft für Bauwesen, Schriftenreihe, Heft 1. Munich and Berlin, R. Oldenbourg, 1933. 68 pp., illus., diagrs., charts, tables, 12 × 8 in., paper, 3.50 rm.

The sewage section of the Deutsche Gesellschaft für Bauwesen offers the first issue of a series upon sewage problems. The organization, aims, and methods of the section are described in this number, which also contains the technical papers presented at its meetings held in 1932 and 1933.

College Textbook of Geology. Part 1, Geologic Processes and Their Results. By R. T. Chamberlin and P. MacClintock. 2 ed. New York, Henry Holt and Co., 1933. 445 pp., illus., maps, tables, diagrs., 9 × 6 in., cloth, $3.

The material covered in the previous edition of this work has been brought up to date, and the discussion of it has been expanded. New material on the occurrence of ground water, on artesian wells, on the origin of mountains and volcanoes, and on other topics has been introduced. Many new illustrations have been added.

Concrete in Road Construction. Ministry of Transport, Roads Department, Technical Advisory Committee on Experimental Work. London, His Majesty's Stationery Office (British Library of Information, New York), 1933. 110 pp., illus., diagrs., charts, tables, 10 × 6 in., paper, 2s, 6d.

This report describes in detail experimental work, carried through a number of years, in actual road construction, laboratory testing, and the examination of cores cut from roads. Such matters as reinforcement, foundations, length of slabs, different types of joints, testing of materials, the effect of water-cement ratio, and similar subjects are discussed. Suggestions for construction work are given.

An Engineer's Outlook. By Sir A. Ewing. London, Methuen and Co., Ltd., 1933. 333 pp., diagrs., 8 × 5 in., cloth, 8s. 6d.

The papers and addresses in this delightful volume include interesting character sketches of Lord Kelvin, Sir Charles Parsons, Fleeming Jenkin, Robert Louis Stevenson, and Lord Balfour. Others discuss the relation of science to modern problems, invention during the last century, power, and magnetism.

Forschungsheft 361. Strömungsgesetze in rauhen Rohren. By J. Nikuradse. Berlin, VDI-Verlag, 1933. 22 pp., illus., charts, diagrs., tables, 12 × 8 in., paper, 5 rm.

The purpose of this investigation was to study the effect of various degrees of wall roughness upon turbulent flow in pipes for any Reynold's numbers, and to determine the laws governing resistance and velocity. The research work is described in detail and discussed fully.

Fundamentierung und Feuchtigkeits-Isolierung von Hochbauten. (Sammlung Göschen 1071.) By K. Hofmann. Berlin and Leipzig, Walter de Gruyter and Co., 1933. 99 pp., illus., diagrs., tables, 6 × 4 in., cloth, 1.62 rm.

The usual methods of constructing foundations for buildings are described concisely, with special attention to difficult ground conditions. Methods of waterproofing are also considered.

Die Gefährdung der Kanalisationsanlagen durch Gase. (Beihefte zum Gesundheits-Ingenieur, Reihe 2, Heft 13.) By K. Ripperger. Munich and Berlin, R. Oldenbourg, 1933. 28 pp., illus., diagrs., tables, 13 × 9 in., paper, 5.20 rm.

An informative study of gases in sewers and their danger. An extensive list of sewer explosions is given, with the causes assigned, which shows the extent of the danger. The kinds of gases found in sewers and their origins are then reviewed, and methods of detection are described. Methods of preventing the formation and accumulation of sewer gas are also discussed.

Procedure Handbook of Arc Welding Design and Practice. By Lincoln Electric Co. Cleveland, Ohio, Lincoln Electric Co., 1933. 434 pp., illus., diagrs., tables, 9 × 6 in., cloth, $1.50.

Contents: Welding methods and equipment; technic of welding; procedures, speeds, and costs for welding mild steel; weldability of metals; designing for arc-welded steel construction of machinery; designing for arc-welded structures; typical applications of arc welding in manufacturing, construction, and maintenance. This work is illustrated by numerous drawings and photographs, and will be helpful to designers as well as welders.

Rayleigh's Principle and Its Applications to Engineering. By G. Temple and W. G. Bickley. London and New York, Oxford University Press, 1933. 156 pp., diagrs., charts, tables, 9 × 6 in., cloth, $4.50.

The purpose of this volume is to familiarize engineers with the utility of Rayleigh's energy method for the rapid, direct calculation of the approximate values of critical loads and speeds. The method is developed in such a way as to furnish both upper and lower estimates of the true value required, so that critical loads and frequencies can be determined with close, known degrees of approximation.

Reinforced Concrete Bridge Design. By C. S. Chettoe and H. C. Adams. London, Chapman and Hall, Ltd., 1933. 400 pp., illus., diagrs., charts, tables, 10 × 6 in., cloth, 42s.

Part 1 (on theory): an outline of structural theory, the character and properties of concrete and their effect upon design, reinforced-concrete design, and live loads. Part 2 (on the design of structures): freely supported spans, continuous-span bridges, arches, portal frames and culverts, and culverts and substructures. Part 3 (on miscellaneous matters): piling, excavation, curves and superelevation, provision for expansion, bridge strengthening and widening, the esthetics of design, and sites. The treatment represents modern British practice. Theory and practice are skilfully blended and are illustrated by examples.

Report on Methods of Providing Traffic Lines in Great Britain. Ministry of Transport, Roads Department, Technical Advisory Committee on Experimental Work. London, His Majesty's Stationery Office (British Library of Information, New York), 1933, 12 pp., 10 × 6 in., paper, 3d.

This report discusses the use of painted and inset lines upon highways to guide traffic. Materials, costs, and methods of application are discussed in the light of experience.

Textbook of Fire Assaying. By E. E. Bugbee. 2 ed. New York, John Wiley & Sons, 1933. 299 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $3.

Although the work is intended primarily as a college text, many mature assayers will find it useful for the presentation of the scientific reasons underlying the phenomena that occur in fire assays and for the careful, detailed explanations of the manipulations. The new edition has been carefully revised and a chapter added upon the assay of ores of platinum-group metals.

Verteilung der Hydraulischen Energie bei Einem Lotrechten Absturz. By H. Rouse. Munich and Berlin, R. Oldenbourg, 1933. 38 pp., illus., diagrs., charts, tables, 11 × 8 in., paper, 3.60 rm.

A theoretical and experimental investigation of the behavior of water when flowing in curved paths. A practical method of determining the pressure at any desired cross section of a falling stream in an open channel is developed.

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THOROUGH CUTS	Du Pont Quarry Gelatin Red Cross Extra Red Cross Blasting Powder—Free Running R. R. P.	When cutting through a hill the explosive to select depends upon the nature of the rock and working conditions Quarry Gelatin for wet outside work; higher strengths for hard rock, and lower ones for soft rocks. If holes are not particularly moist, Red Cross Extra. For deep holes in fairly dry work, the Free Running Red Cross Blasting Powders are economical.
SIDE HILL CUTS	Du Pont Quarry Gelatin Red Cross Extra Red Cross Blasting Powder—Free Running Blasting Powder	Hard rock, Quarry Gelatin; softer materials, Red Cross Extra grades, or in dry work, Free Running Red Cross Blasting, or granular black powder. In working from the side, if excavated material is to be used for filling, loads should be barely heavy enough to break ground for convenient handling. In working from the end, rules for thorough cuts apply. Use same explosives.
EARTH SIDE HILL CUTS	Red Cross Extra —20% Red Cross Blasting Powder No. 2 — Free Running Blasting Powder	Loosen ground with light blasts for road machines, or hand digging. Blast trees, stumps and boulders from side and out-fall ditches. Widen and straighten cuts and blast down gravel with Red Cross Extra 20%, Red Cross Blasting No. 2 F. R., or blasting powder.
GRAVEL PITS	Red Cross Extra —20% Red Cross Blasting Powder No. 2 — Free Running	In blasting to obtain grading material, holes are spaced as for other blasting. If rock is not encountered, holes are loaded lighter, merely to loosen material for easy digging. Use Red Cross Extra 20% and Red Cross Blasting No. 2 F. R.
BOULDERS	Red Cross Extra —20%—40% Du Pont Extra D Agritol	For mudcapping, remove dynamite from shell, pack it in a conical heap on the boulder; insert cap and fuse, cover explosive with several inches of thick, heavy mud. Never lay stones on top of mudcap. For snake-holing, punch hole beneath and against boulder. Tamp charge compactly. Use Red Cross Extra 20% or 40%, du Pont Extra D, or Agritol where heavy soil under boulders provides required resistance.
QUARRYING	Red Cross Extra —40% Du Pont Extra Du Pont Quarry Gelatin Du Pont Gelatin Gelex	To crush stone for road building, use Red Cross 40%, du Pont Extra, Gelatin, or Gelex. Tamp holes well and fire simultaneously. For quarrying dimension stone, use blasting powder of fine granulation to start cracks and seams in desired direction. For extremely hard rock, du Pont Quarry Gelatin.
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DITCHING	Du Pont Ditching Dynamite	Ditches can be blasted in wet soil by the propagation method; the electric method can be used in wet or dry soil. In wet soil, du Pont Ditching Dynamite, which blasts by propagation, effects economies in time, labor and money.
STUMPS	Red Cross Extra —40% Agritol Red Cross Extra —20% Loggers' Powder (Pacific States)	For blasting green, lateral rooted stumps, use 40% Red Cross. For tap-rooted stumps, Agritol, or, if soil is heavy, Red Cross Extra 20%; if light soil, Red Cross Extra 40%. Blast tap-rooted stumps out of light soil, with Red Cross Extra 40%. Du Pont Loggers' Powder for the Pacific Northwest.

CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own file, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, plus postage, or technical translations of the complete text may be obtained at cost.

BRIDGES

Concrete Arch, New Zealand. Reconstruction of Upper Manawatu Gorge Bridge, W. L. Newnham. *New Zealand Soc. Civ. Engrs.—Proc. 1932–1933*, vol. 19, 1933, pp. 290–309 (discussion) 309–313, 3 supp. plates. Design and construction of highway bridge consisting principally of four 80-ft. spans of reinforced-concrete open-spandrel arches, carried on reinforced concrete piers and abutments, axis of arch barrel being arc of circle; cost data.

Concrete Girder, New Zealand. Waihou Bridge, Te Aroha, R. C. Adams. *New Zealand Soc. Civ. Engrs—Proc., 1932–1933*, vol. 19, 1933, pp. 352–361 (discussion), 361–362, 2 supp. plates. Design and construction of reinforced-concrete highway bridge consisting of ten 40-ft girder spans, a roadway 18 ft wide, and sidewalks $4\frac{1}{2}$ ft wide; cost data.

Construction. Multiple Arch Concrete Bridge Built on Timber Falsework, F. C. Hart. *Construction Methods*, vol. 15, no. 8, Aug. 1933, pp. 22 and 23. Use of inexpensive job-assembled traveler for the erection of timber falsework for the White River Bridge between Branson and Hollister, Mo., having a total length of 1,087 ft, consisting of two 56-ft deck girder approach spans, one at each end of the structure, and five 195-ft, two-rib, open-spandrel concrete arches supporting a 20-ft roadway, with 5-ft sidewalks on each side, about 50 ft above river surface.

Floors. Using Arc Welding to Save Weight in Bascule Bridge Reconstruction, A. G. Bissell. *Am. Welding Soc.—Journal*, vol. 12, no. 9, Sept. 1933, pp. 14–17. New departure in bridge-floor construction is the use of open grating flooring, in the widening and reconstruction of the bascule span of the University Bridge, Seattle, Wash.; two additional 8-ft 10-in. roadways to original 40-ft roadway; nearly all material added to bascule span was of arc-welded construction.

Missouri. Self-Anchored Suspension Bridge Built in Missouri, H. Mullins. *Eng. News-Rec.*, vol. 111, no. 13, Sept. 28, 1933, pp. 367–370. Description of stiffened self-anchored suspension bridge crossing the Lake of Ozarks, in Missouri, having a main span of 225 ft; stiffening girders are 33-in. rolled beams, and cables are prestressed twisted strands.

Plate Girder, Denmark. Storstroem Bridge, Denmark. *Engineering*, vol. 136, no. 3532, Sept. 22, 1933, p. 347. Details of approaches and foundations of reinforced-concrete piers of this structure; chief obstacle to carrying out work of constructing piers will probably be floating ice; method of construction that will allow work to be rapidly completed, once it has been started.

Steel, Welding. Welding Progress Facilitates Bridge Reconstruction and Repair, A. Vogel. *Iron Age*, vol. 132, no. 13, Sept. 28, 1933, pp. 18–23. Progress in development of heavily-coated electrodes has made possible effective use of welding for strengthening, reconditioning, and fabrication of highway and railroad bridges; results of tension, bend, impact, shear, and other tests that show suitability of welding for this work are cited.

Steel Truss, Vancouver, B.C. Burrard Bridge, Vancouver, J. R. Grant. *Eng. Journal*, vol 16, no. 9, Sept. 1933, pp. 379–388. Design and construction of reinforced-concrete viaduct and 5-span steel-truss bridge, including lift span about 300 ft long; total length is 2,800 ft, of which 1,151 ft is of steel-truss construction; provisions for future lower deck to carry double railroad track; cost data; total cost $1,845,000. Before Eng. Inst. Canada.

Stresses. Theory of Probability Applied to Bridge and Building Loadings, B. R. Leffler. *Am. Ry. Eng. Assn.—Proc.*, vol. 34, mtg. March 14–15, 1933, pp. 731–736. Mathematical probability; probability curve applied to multiple-track bridge; six-track, five-track, and four-track bridges considered; highway bridge loadings; building loads.

Sweden. Traneberg Arch Bridge, Stockholm. *Engineer*, vol. 156, no. 4053, Sept. 15, 1933, pp. 261–264 and 258. Bridge has a total length, including viaduct approaches, of 580 m; reinforced-concrete arch over waterway has a clear span between abutments of 178.4 m; falsework employed for construction of twin concrete arches consisted of steel arch which, after being used for first concrete arch, was moved to position of second arch and used again.

Welding. Repairing Small County Bridges by Arc Welding, H. K. Ellis. *Am. Welding Soc.—Journal*, vol. 12, no. 9, Sept. 1933, pp. 22–24. Arc weld repairing and building of six all-welded short steel-truss spans, longest being 55 ft 8 in., in Chester County, Pennsylvania.

BUILDINGS

Earthquake Effects. Long Beach Earthquake—and Afterwards, H. M. Hadley. *Western Construction News and Highways Bldr.*, vol. 8, no. 15, Sept. 1933, pp. 395–397. Notes and comments on effect of earthquake on buildings of various designs and materials; recommended types of design and construction.

New Zealand. Hawke's Bay Earthquake. *New Zealand Journal Science and Tech.*, vol. 15, no. 1, July 1933, 116 pp., supp. plates. Symposium on Hawke's Bay earthquake of February 3, 1931, including the following papers: General Description, F. R. Callaghan; Geological Aspects of Hawke's Bay Earthquakes, J. Henderson; Sponge Bay Uplift, Gisborne, and Hangaroa Mud Blowout, S.W.S. Strong; Effects of Earthquake on Coastline near Napier, P. Marshall; Seismological Report of Hawke's Bay Earthquake, C. E. Adams; Damage to Buildings, A. Brodie and A. G. Harris.

Prisons, Concrete. Cell House of Monolithic Concrete at Illinois Prison, B. E. Hadley. *Concrete*, vol. 41, no. 9, Sept. 1933, pp. 7 and 8. First state-owned building to be built entirely of monolithic concrete, both exterior and interior; concrete of high quality obtained through careful supervision; thin cell walls heavily reinforced; roofing tile of precast colored concrete.

CONCRETE

Cement Mortar, Curing. Effect of Curing Conditions on Strength of Cement Mortar, D. O. Woolf and K. F. Shippey. *Pub. Roads*, vol. 14, no. 6, Aug. 1933, pp. 106–108. Results of tests made by the U.S. Bureau of Public Roads; study of variation of strength with age; loss of strength attributed to solution of part of cement in storage water; tests fail to confirm theory attributing loss of tensile strength to unequal stress distribution in briquet; tests indicate that standard curing practice is satisfactory.

Columns, Testing. Amerikanische Saeulenversuche, M. Thullie. *Beton u Eisen*, vol. 32, no. 9, May 5, 1933, p. 148. Summary and discussion of results of University of Illinois tests for reinforced-concrete columns. Discussion of article previously indexed from issue of Jan. 5, 1933.

Construction, Pump Placing. Pump Concrete 600 Ft on Viaduct Contract in Milwaukee. *Concrete*, vol. 41, no. 9, Sept. 1933, pp. 3 and 4. Continuous flow of concrete delivered at rate of 27 cu yd per hr; use of ready-mixed concrete from commercial plants; concreting deck slab; concrete maintains high quality; pumping unit is single-cylinder unit with gasoline-engine drive; it is not in any sense automatic.

Reinforcement. New Form of Reinforcement for Concrete. *Concrete and Constr. Eng.*, vol. 28, no. 9, Sept. 1933, pp. 533 and 539. Properties and special advantages of "Isteg" twisted reinforcement bars used in Central Europe since 1928; results of tests.

Retaining Walls. Data for Design of Retaining Walls, A. H. T. Williams. *Concrete*, vol. 41, no. 9, Sept. 1933, p. 10. Chart supplying necessary data for conditions usually encountered.

Rock Products Industry, Industrial Codes. Mineral-Aggregates Code Presented to NRA in Altered Form. *Pit and Quarry*, vol. 26, no. 3, Sept. 1933, pp. 23–28 and 40. Revised code of fair competition for crushed-stone sand and gravel, and slag industries, involves important changes affecting hours of labor and rates of pay.

Swimming Pools, Great Britain. Hastings Bathing Pool. *Engineer*, vol. 156, no. 4051, Sept. 1, 1933, pp. 206–208. New open-air pool has length of 330 ft and width of 90 ft; whole of pool and surrounding structures carried out in reinforced concrete, bulk of aggregate being obtained from material excavated from site; pool holds 900,000 gal of water.

Vibrating. Versuche mit Ruettelbeton, Vieser. *Zement*, vol. 22, no. 33, Aug. 17, 1933, pp. 465 and 466. Tests with vibrated concrete; report on experiments of L. Santarella at Milan Special Academy for Reinforced-Concrete Construction.

Welding. Die elektrische geschweisste Naht im Eisenbetonbau, E. Lucan. *Beton u Eisen*, vol. 32, no. 718, Apr. 5, 1933, pp. 127–129. Use of electric welding in splicing concrete reinforcing bars; features of welding equipment used; cost data.

CONSTRUCTION INDUSTRY

Costs. Unit Bid Summary. *Western Construction News and Highways Bldr.*, vol. 8, no. 15, Sept. 1933, pp. 398, 400, 402, and 404. Unit prices bid on tunnel construction, bridges, culverts, street, and road work in California, Oregon, Montana, New Mexico, and other Western states.

Embankments Construction. Stream Diversion and Dike Construction via Belt Conveyor. *Contractors and Engrs. Monthly*, vol. 27, no. 3, Sept. 1933, pp. 21–24. Use of belt-conveyor system for handling excavation from river channel to dike for forming new 100-acre waste dump for Diamond Alkali Company near Painesville, Ohio.

Equipment, Rollers. Remarkable Roller. *Engineer*, vol. 156, no. 4052, Sept. 8, 1933, pp. 240–241; see also *Engineering*, vol. 136, no. 3530, Sept. 8, 1933, p. 242. Special steam roller constructed by Marshall, Sons and Company for purpose of embankment consolidation; principles governing use of embankment roller.

DAMS

Cleaning. Distribution Reservoir Cleaned by Means of Siphon Drain Line, S. S. Anthony. *Water Works Eng.*, vol. 86, no. 19, Sept. 20, 1933, pp. 925 and 926. Experience of Augusta, Me., Water District in cleaning distribution reservoir by means of 6-in. siphon, leading from pipe in reservoir up over embankment into drainage ditch; operation of siphon; cleaning of concrete.

Earth. New Principles Applied to Actual Dam-Building, R. R. Proctor. *Eng. News-Rec.*, vol. 111, no. 13, Sept. 28, 1933, pp. 372–376. Concluding article on design and construction of rolled-earth dams; application of principles of soil compaction; experience with sheepsfoot roller of extra heavy design; measurement of plasticity-needle penetration resistance and dry weight of test fill compacted to determine required number of trips and weight of sheepsfoot-type rollers for construction of Bouquet Dam No. 1; summary of field and laboratory tests.

Failure Slide in Belle Fourche Dam Follows Reservoir Drawdown. *Eng. News-Rec.*, vol. 111, no. 13, Sept. 28, 1933, p. 371. Description of slide, 600 ft long, on upstream face of Belle Fourche Dam; repairs require 20,000 cu yd of earth and replacement of 1,500 concrete paving blocks.

Flood Gates. Ingenious Design for Flood Gates, R. E. Potter. *Eng. and Contract Rec.*, (*formerly Contract Rec.*), vol. 47, no. 37, Sept. 13, 1933, pp. 863 and 864. Description of series of automatic shutters on top of Granby Dam, at Grand Forks, B.C., which fall down in succession after first one is released, thus relieving flood stage in reservoir.

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Hoover Dam Project, Trash Racks. Trash Racks for Intake Towers at Boulder (Hoover) Dam. *U.S. Bureau of Reclamation—Specifications*, no. 547, 1933, 10 pp., 1 supp. plate. Price $0.30. Invitation for bids schedule, specifications, and drawing contract calls for some 1,400 regular and bottom sections of structural steel trash racks details, of which are given on drawing.

Hydraulic Fill, California. El Capitan Dam Contains 1,700,000 Cu yd of Hydrualic Fill. *Construction Methods*, vol. 15, no. 9, Sept. 1933, pp. 18–21. Design and construction of El Capitan hydraulic-fill dam, 217 ft high, 1,200 ft long, for the municipal water supply of San Diego, Calif.; heavy rock-fill sections enclose upstream and downstream sides of hydraulic fill.

Movable. A-Frame Type Dam Readopted for Cumberland River, F. S. Besson. *Eng. News-Rec.*, vol. 111, no. 14, Oct. 5, 1933, pp. 401 and 402. Construction of A-frame crest on navigation dam in Cumberland River increases head $4^1/_2$ ft and gives harbor at Nashville, Tenn., navigable depth of 9 ft; method of operating frames.

Reservoirs, Concrete. Methods Adopted by New Haven Water Company in Waterproofing New Reservoir, E. E. Minor. *Water Works Eng.*, vol. 86, no. 19, Sept. 20, 1933, pp. 927–929. Method of construction of heavy concrete lining for Mill Rock distribution reservoir in New Haven, Conn.; landscaping of reservoir site; construction of floor slabs and side walls; excavation material used in embankment; total cost $200,000.

FLOOD CONTROL

Damage. Tree and Crop Damage in Flood-Detention Basins, C. H. Eiffert. *Eng. News-Rec.*, vol. 111, no. 13, Sept. 28, 1933, pp. 370 and 371. Flood hydrograph for Englewood retarding basin of Miami Conservancy District, Ohio, show that from $2^1/_2$ to $6^1/_2$ days' submergence are required to destroy grain crops.

Flood Discharge. Maximum Flood Flow Prediction, F. S. Besson. *Military Engr.*, vol. 25, no. 143, Sept.–Oct. 1933, pp. 423–426. Method used by Nashville District, U.S. Corps of Engineers, for determining probable maximum discharges for Cumberland River basin; extrapolation of duration curves; drainage area-flow formulas; limited and sustained storms; ground conditions; discharge anomalies; factor of safety; approximate discharges of historic floods and estimated possible future maximum discharges.

FOUNDATIONS

Caissons, Steel, Electric Welding. Arc Welding Helps Solve Problem of Under Water Structure for New San Francisco Bridge, A. F. Davis. *Am. Welding Soc.—Journal*, vol. 12, no. 9, Sept. 1933, pp. 13 and 14. Welding of cutting edges and caissons for open bridge set new record for depth below water; center anchorage of bridge is 197 ft long, 92 ft wide and, when placed, will be 237 ft from lower cutting edge to top.

Piles, Concrete, Driving. Wave Theory Applied to Driving of Reinforced Concrete Piles, D. V. Isaacs. *Engineering*, vol. 136, no. 3529, Sept. 1, 1933, p. 211. Definite conclusions made from theory; writer considers that, at present, criterion for applying formula is whether or not initial driving resistance, after period of rest, differs widely from resistance during driving.

Testing. Sampling and Soil Tests for Bay Bridge, San Francisco, D. E. Moran. *Eng. News-Rec.*, vol. 111, no. 14, Oct. 5, 1933, pp. 404–406. Method of taking soil samples at great depths (250 ft) to which foundations of San Francisco-Oakland Bridge penetrate; results of sample tests; consolidation tests; testing apparatus.

HYDROLOGY, METEOROLOGY, AND SEISMOGRAPHY

Meteorology. Variations of Wind and Cloudiness in Eastern Australia, and their General Significance to Aviation; J. Macdonald Holmes. *Inst. Engrs. Australia—Journal*, vol. 5, no. 7, July 1933, pp. 233—236. Zones in atmosphere; local "ground-level" in air behavior; gustiness of ground-level winds; large-scale weather behavior; squall line type of weather. Bibliography.

LAND RECLAMATION AND DRAINAGE

Drainage Pumping Plants. Handling London's Main Drainage. *Power Engr.*, vol. 28, no. 330, Sept. 1933, pp. 325–332. New pumping machinery installed by London County Council at their Lots Road and Deptford pumping stations; oil and gas engines are in use at Lots Road, and oil engines and synchronous electric motors at Deptford; illustrations and plan drawings.

Great Britain. Land Reclamation on River Tees. *Civ. Eng.* (*London*), vol. 28, no. 324, June 1933, pp. 211–215, 1 supp. plate. Construction of timber revetment 7,600 ft long, driving of 3,800 piles, building of pumping plant and similar works for reclamation of land estuary of River Tees, where 3,350 acres have, so far, been reclaimed for industrial sites.

MATERIALS TESTING

Cement Mortar, Testing. Steam Test of Portland Cement Mortar Briquettes, A. E. Hiscox. *Rock Products*, vol. 36, no. 9, Sept. 25, 1933, pp. 34–36. Series of comparative tests of several brands of American cements; from tests it would appear that the loss of strength from steaming is due to expansive forces derived principally from hydration of free lime.

PORTS AND MARITIME STRUCTURES

Cargo Handling Equipment. Some Considerations Affecting Dock Equipment, R. M. Dymond. *Inst. Mech. Engrs.—Proc.*, vol. 123, July–Dec. 1932, pp. 805–817. Mechanical equipment and methods of handling cargo in dock system; port activity; general cargo; shipside movement; capacity of appliances; operating area; motive power; operating speeds; quayside and transit-shed movement; trucking; bulk-cargo handling; conveyors.

Cherbourg. Cherbourg Develops Port Facilities for Docking Transatlantic Liners, V. Delport. *Mar. Rev.*, vol. 63, no. 10, Oct. 1933, pp. 12–14. Brief historical review; commercial port facilities; details concerning new transatlantic dock; quickness of despatch.

Docks, Floating. Vorrichtung zur Bestimmung von Belastungsaenderungen von Schwimmdocks, F. Winkler. *Schiffbau*, vol. 34, no. 17, Sept. 1, 1933, pp. 301–303. Device for determining load fluctuations of floating dock; simple practical method of dealing with load fluctuations by freeing of individual pontoons, and without causing change in trim of dock.

Havre, France. Les travaux de déplacement de la dique sud de l'avant-port du Havre, L. Gain. *Technique des Travaux*, vol. 9, no. 8, Aug. 1933, pp. 485–501. Demolition of old southern mole of Port of Havre and construction of new one to fit port for sheltering of superliners of Normandie type; new mole section consists of rock embankment and cellular reinforced concrete blocks totaling 13.3 m in height; details of reinforced-concrete caissons, artificial island, etc.

Italy. Fortschritte der italienischen Hafentechnik, W. Teubert. *Schiffbau*, vol. 34, no. 12, 13, 15, and 17; June 15, 1933, pp. 227–230; July 1, pp. 240–242; Aug. 1, pp. 271–275; and Sept. 1, p. 307. Progress in Italian harbor construction; extensions to Italian ports; maps and illustrations showing improvements at ports of Genoa, Naples, Palermo, Catania, Augusta, and Syracuse; progress in construction of quays, nautical equipment, and harbor approaches, port railroads; cargo-handling and storage equipment.

ROADS AND STREETS

Asphalt. Aggregate Producers are Logical Makers of Asphalt Paving Mixes. *Pit and Quarry*, vol. 26, no. 3, Sept. 1933, pp. 39 and 40. Growing use of, and demand for, low-cost pavements has resulted in the development of many types of patented asphaltic mixtures; West Process Pavement Company plans to install process in aggregate plants.

Bituminous. Evaporation et oxydation des revetements à base de goudron de houille, A. Leaute. *Journal des Usines à Gaz.*, vol. 57, no. 15, Aug. 5, 1933, p. 398. Evaporation and oxidation of coal tar road surfacings; experiments with prepared tar for road surfacing, from which water and heavy oils have been extracted; tests of filler made up of 40 per cent carbon and 35 per cent lime.

Brick. Method of Removing Surplus Filler in Brick Pavement Construction, O. W. Merrell. *Roads and Streets*, vol. 76, no. 8, Aug. 1933, pp. 299 and 300. Removal is accomplished by coating brick just prior to application of filler with whitewash, calcium chloride in solution, or a patented mixture whose trade name is B and B. Before Nat. Paving Brick Assn.

Canada. Twentieth Annual Meeting of Canadian Good Road Association. *Eng. and Contract Rec.* (*formerly Contract Rec.*), vol. 47, no. 38, Sept. 20, 1933, pp. 878–890. Proceedings of annual meeting including abstracts of principal papers.

Concrete. Removing Cork From Bottleneck. *Roads and Streets*, vol. 76, no. 8, Aug. 1933, pp. 285–289. Description of modern methods of concrete road construction used in widening three-mile section of Roosevelt Road, 30 miles west of Chicago.

Construction. Relation of Geological Formations to Road Material Surveys, D. G. Runner. *Roads and Streets*, vol. 76, no. 8, Aug. 1933, pp. 301–303. Description of geological formations that are likely to be encountered in making survey, and their effect upon the amount of material that may be economically recovered.

Drainage. Paving Side Ditches for Hilly Roads, D. M. Norton. *Eng. News-Rec.*, vol. 111, no. 12, Sept. 21, 1933, pp. 351 and 352. Description of cheap stone paving developed from trial by the maintenance department of the Indiana State Highway Commission; sections, templets, and pavement details.

Driveways. How to Design Practical Curved Driveways, E. I. Freese. *Am. Architect*, vol. 143, no. 2619, Sept. 1933, pp. 33–38. Diagrams and tables for design of circular and other curved automobile driveways; minimum standard dimensions for circular driveways; dimensions of compound driveway quadrants.

SEWERAGE AND SEWAGE DISPOSAL

Australia. Sewerage Works at Colac, Echuca, and Mildura, and Experience Obtained in their Operation, E. T. M. Garlick. *Inst. Engrs. Australia—Journal*, vol. 5, no. 8, Aug. 1933, pp. 270–282. Design and operation of three sewage disposal plants serving a population of about 16,000; grading of sewers; fluorescin tests for velocity of flow in sewers; sludge digestion; nitrification of liquor from sedimentation process; efficiencies of centrifugal pumps and ejectors.

Berlin, Germany. Die Zukuenftige Gestaltung der Berliner Abwasserreinigung, H. Ehlgoetz. *Gesundheits-Ingenieur*, vol. 56, no. 30, July 29, 1933, pp. 354–356. Development of sewers and sewage disposal system of Berlin; sewage irrigation versus sewage treatment; experimental sewage disposal research; political and hydrological aspects of problem.

Cast Iron Sewers. Dearborn Sewage Sludge Pumped Through Long Pipe Line, G. E. Hubbell. *Eng. News-Rec.*, vol. 111, no. 12, Sept. 21, 1933, p. 343. Testing of 8-in. cast-iron sludge line, 20,466 ft long, connecting existing Imhoff tank plant at Miller Road with new West Side plant at Dearborn, Mich.; line shows Hazen-Williams coefficient of 126 when conveying sludge of 0.5 per cent solids.

Chlorination. Chlorination of Sewage for Prevention of Septicity, J. Haworth. *Soc. Chem. Industry—Journal*, (*Trans. and Communications*), vol. 52, no. 37, Sept. 15, 1933, pp. 293T–296T. Laboratory experiments; it follows from results given in table that chlorine is an effective agent for the prevention of septicity; efficiency of chlorine has been quantitatively determined for numerous different sewage samples, and there is evidence that chlorination to fraction of chlorine demand is sufficient to prevent septicity during incubation for 7 days at 20 C.

Chlorination, Detroit, Mich. Ammonia-Chlorine Treatment Yields Nitrites in Effluent R. Hulbert. *Eng. News-Rec.*, vol. 111, no. 11, Sept. 14, 1933, pp. 315 and 316. Observations of Detroit water department on soil bacteria in filter converting ammonia to nitrite, which presents a large chlorine demand and interferes with the orthotolodine test for residual chlorine.

Coagulation. History of Chemical Precipitation, L. B. Reynolds. *Sewage Works Journal*, vol. 5, no. 4, July 1933, pp. 595–599. Nature of process; experience in England, France, Germany, and the United States; chemicals: English, German, and American plants. Before Calif. Sewage Works Assn.

Concrete Sewers. What Australia Thinks of Concrete Sewer Pipe. *Brick and Clay Rec.*, vol. 83, no. 4, Oct. 1933, pp. 128 and 129. Abstracts of Report of Royal Commission of Investigation into Certain Matters Under Administrative Control of Metropolitan Board of Water, Sewerage, and Drainage, Sydney; commission finds use of concrete pipe must be limited and subjected to definite restrictions; kinds of pipe; causes of failure; where failures are likely to occur.

Costs. Cost Analysis of Ensley Sewage Treatment Plant, Birmingham, Alabama, H. H. Hendon and M. E. Boriss. *Water Works and Sewerage*, vol. 80, no. 8, Aug. 1933, pp. 275–279. Description and cost analysis of following units; separate sludge digestion plant designed to treat 15 MGD; screenings; grit removal; sewage meter; settling tanks; sludge pumping; digesters; gas collection and digester heating; gas holder; sludge drying beds; sludge piping and control chambers; outside sewers; and water supply.

Disposal Plants, Operation. Symposium—Operation of Small Sewerage Systems and Treatment Plants. *Sewage Works Journal*, vol. 5, no. 4, July 1933, pp. 645–651. Symposium consisting of the following papers: Operation of Small Sewerage Systems and Treatment Plants, W. A. Ryan; Covered Sludge Drying Beds and Sludge Drying at Town of Tonawanda, Plant No. 2, A. W. Evans; Sludge Disposal at Town of Tonawanda, Plant No. 3. Before New York State Sewerage Works Assn.

Filters. Aldershot Sewage Disposal Experiments, J. W. Edwards. *Surveyor*, vol. 84, no. 2172, Sept. 8, 1933, p. 204. Comparative performance of gravel, metallurgical coke, and clinker as media used in the construction of new percolating filters at the Aldershot sewage works; experiments with method of drying sludge; experiment to ascertain minimum amount of independent heat required to work one of beds.

Flow Meters. Constant Head Flow Meter, W. Gavett. *Water Works and Sewerage*, vol. 80, no. 8, Aug. 1933, p. 282. Variable-orifice meters designed by author for the new sewage

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treatment works at Morristown, N.J., to indicate the flow of effluent and also the returned and waste activated sludge; meters consist of submerged stationary tube with two narrow longitudinal orifices; circular plate fits loosely in tube and is supported by chain counterweighted at other end and hung over sheave.

Great Britain. Sewage Treatment and Disposal. *Surveyor*, vol. 84, no. 2174, Sept. 22, 1933, pp. 247–249 (discussion) 249 and 250. Abstracts and discussions of several papers presented before meeting of Section G, British Assn. for Advancement of Science, held at Leicester, including the following: Legal Aspect of River Pollution, with Special Reference to River's Pollution Prevention Acts, H. Fatter; Purification of Sewage by Natural Processes, W. E. Adeney and A. G. G. Leonard; Modern Methods of Sewage Purification, J. Haworth; Treatment and Utilization of Sludge, F. C. Vokes.

STRUCTURAL ENGINEERING

Arches, Design. Method of Deriving Bending-moment Diagram for Fixed-ended Arch under Dead Loads, R. E. Wallis. *Civ. Eng. (London)*, vol. 28, no. 324, June 1933, p. 209. Development of graphical method and presentation of numerical examples.

Beams, Concrete. Flexion composée des poutres rectangulaires en béton armé, H. Deshays. *Technique des Travaux*, vol. 9, no. 7, July 1933, pp. 441–447. Construction of alignment chart for determination of minimum reinforcement required in reinforced-concrete beams or rectangular cross sections subjected to combined flexure.

Chimneys, Design. Schornsteinhoehe und-durchmesser, Lohoff. *Brennstoff-und Waermewirtschaft*, vol. 15, no. 7, July 1933, pp. 109–112. Height and diameter of chimneys; factors governing height; charts and formulas for calculation of dimensions.

Floors, Concrete. Concrete Floors:—Flat Slab versus Ribbed Construction, W. S. Wilson. *Civ. Eng. (London)*, vol. 28, no. 325, July 1933, pp. 266 and 267. Comparison of flat-slab and ribbed construction for floors, with special reference to engineering features and costs.

Trusses, Design. Le calcul pratique des poutres Vierendeel, G. Magnel. *Technique des Travaux*, vol. 9, no. 8, Aug. 1933, pp. 504–511. Derivation of mathematical formulas for practical design of Vierendeel trusses.

TUNNELS

Railroad, Lining. Water Conduit Service Requires Steel Liner Plates in Moffat Pioneer, Bore. *Construction Methods*, vol. 15, no. 9, Sept. 1933, pp. 22–24. Installation of $^1/_4$ by 16 by 36-in. steel liner plates in section of Moffat Tunnel, 30,000 ft long, to replace temporary timber lining; gunite is sprayed on liner plates to protect them from rust prior to the placing of the 18-in. concrete lining.

Vehicular, Lighting. Lighting Wawona Tunnel, J. F. Morton. *Elec. Journal*, vol. 30, no. 10, Oct. 1933, pp. 429 and 430. Equipment, considerations in design, and price of units used for the lighting of the new 4,230-ft tunnel, providing a shorter and safer route into the Yosemite Valley from southern California.

Water Supply, Costs. Summary of Principal Unit Prices, 19 Contracts, Colorado River Aqueduct Tunnels. *Eng. News-Rec.*, vol. 111, no. 13, Sept. 28, 1933, p. 396. Range of unit prices of principal items of 19 water-supply tunnels, totaling 57.8 miles in length.

WATER PIPE LINES

Cross Connections. Piping Sickness to Consumer, N. N. Wolpert. *Water Works Eng.*, vol. 86, no. 17, Aug. 23, 1933, pp. 823–825. Further cases illustrating dangers of cross connection and siphon action; ammonia taints in Cincinnati water.

WATER TREATMENT

Analysis. Apparatus for Rapid Estimation of Oxygen or Other Gases Dissolved in Water, R. C. Hoather. *Soc. Chem. Industry—Journal, (Chem. and Industry)*, vol. 52, no. 34, Aug. 25, 1933, pp. 689 and 690. Apparatus provides rapid means of expelling gases from sample of water by boiling under slightly reduced pressure, followed by collection, measurement, and treatment of gases with absorbents.

Chlorination. Ortho-Tolidine Test for Chlorine, H. W. Adams. *Am. Water Works Assn.—Journal*, vol. 25, no. 8, Aug. 1933, pp. 1118–1136 (discussion) 1136–1139. Nature of ortho-tolidine reaction; preparation of chlorine standards; influence of chloramines on ortho-tolidine color, reactions of manganese compounds, chlorine and ortho-tolidine reaction; estimation of manganese in waters, and residual chlorine in presence of manganese. Bibliography.

Distilling Apparatus. Ein vollautomatischer Destillier- und Konzentrierapparat, etc., E. Spiegelberg. *Chemische Fabrik*, vol. 6, no. 26, June 28, 1933, pp. 285 and 286. Automatic distilling and concentration apparatus; application to production of distilled water and to production or concentration of dissolved materials.

Filtration Plants, Operation. Operation of Water Filtration Plants. *Am. Water Works Assn.—Journal*, vol. 25, no. 8, Aug. 1933, pp. 1084–1106. Symposium consisting of the following: Introduction, N. J. Howard; Brantford Plant, F. P. Adams; Ottawa Plant, H. P. Stockwell; St. Thomas Plant, W. C. Miller; Windsor Plant, J. C. Keith.

Filtration Plants, Operation. Spring-Summer Operation at Lake Michigan Filter Plants. *Eng. News-Rec.*, vol. 111, no. 9, Aug. 31, 1933, p. 250. Operating results of six filtration plants on Lake Michigan north of Chicago during the months of April, May, and June, showing certain anomalous conditions; settling time; filter rates; filter runs; taste and odor control.

Iron Removal. Iron Removal Plant Paid for From Earnings, E. R. Wells. *Pub. Works*, vol. 64, no. 9, Sept. 1933, pp. 18–20. Description of water treatment plant at Geneva, Ill., serving a population of 5,000; coke tray aerator iron removal plant designed by Graver Tank and Mfg Corp. of East Chicago, Ind.

Lime. Bacterial Efficiency of Excess-Lime Method of Water Purification, H. W. Streeter. *Pub. Works*, vol. 64, no. 8, Aug. 1933, pp. 17–20. Review of problems and report of results of experiments by the U.S. Public Health Service in Cincinnati; comparative average numbers of bacteria observed coincidently in same water with and without excess lime treatment; comparative efficiencies of bacterial removal with varying degrees of causticity in lime-treated water, as applied to filters.

Lime Recovery. Lime Recovery from Water Treatment Plant. *Indus. Chemist*, vol. 9, no. 102, July 1933, pp. 299–332. Description of lime recovery process of the Southend Water Works Company; purification plant; plant equipment.

Metallic. Treatment of Water by Certain Forms of Silver, J. Gibbard. *Am. Journal Pub. Health*, vol. 23, no. 9, Sept. 1933, pp. 910–916. When water is exposed to metallic silver, it develops oligodynamic properties reaching a maximum in about 8 days; water which has been exposed to silver has property of sterilizing polluted water mixed with it; system recommended for use in swimming pools, laundries, ice plants, etc.; claims for medicinal applications. Bibliography.

Sand Washing. Die Reinigung des Kieses in Schnellfilteranlagen, A. Kolibay. *Gesundheits-Ingenieur*, vol. 56, no. 30, July 29, 1933, pp. 352–354. Review of German practice in washing rapid sand filters; investigation of filter washing phenomena.

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Aqueducts, Los Angeles, Calif. Increasing Capacity of Los Angeles Aqueduct, J. E. Phillips. *Am. Water Works Assn.—Journal*, vol. 25, no. 8. Aug. 1933, pp. 1047–1052. Refinishing the interior of the Los Angeles aqueduct, at an estimated cost of $380,000, so as to enable it to carry an additional mean annual flow of 440 cu ft per sec from Mono Basin.

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Great Britain. Ryburn Water Works of Wakefield Corporation. *Engineering*, vol. 136, no. 3531, Sept. 15, 1933, pp. 288–290 and 292. Catchment area is 2,575 acres; first part of scheme constructed was the pipe line, which was carried a distance of 22 miles; tunnel is 808 yd long and ends in balancing tank; capacity of main is 5,600,000 gal per day; second part of scheme consists of a compensation reservoir formed by constructing a dam below the confluence of the Ryburn and Bogden rivers; dam impounds 220,000,000 gal of water, and will provide, 1,300,000 gal per day delivered as compensation water.

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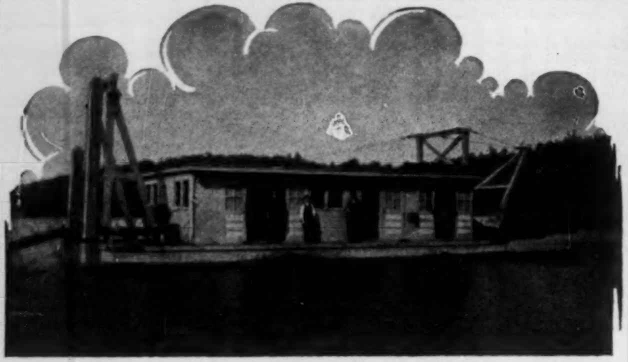

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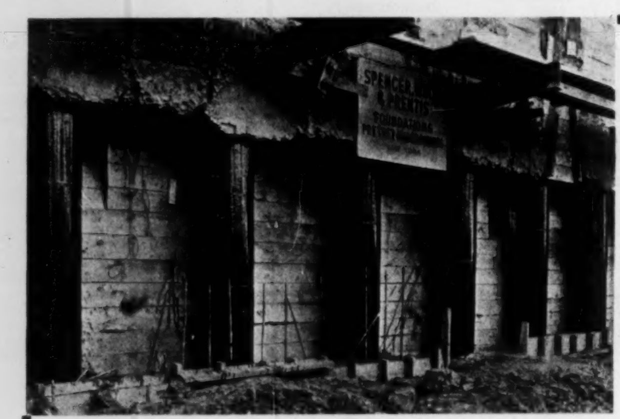

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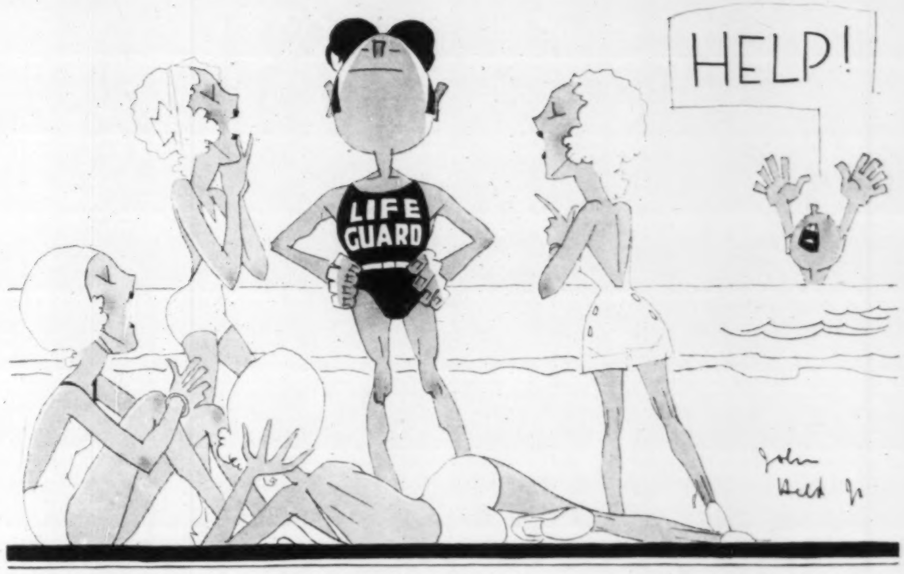

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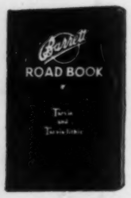

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